

INSECTS OF HAWAII

A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on their Origin, Distribution, Hosts, Parasites, etc.

VOLUME 13

DIPTERA: CYCLORRHAPHA III,
SERIES SCHIZOPHORA
SECTION ACALYPTERAE, EXCLUSIVE
OF FAMILY DROSOPHILIDAE

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PREFACE TO VOLUME 13

This volume deals with the acalyptrate flies of the Hawaiian Islands, with the exception of the family Drosophilidae. It treats two hundred and nine species belonging in ninety-five genera, fifteen subgenera, and twenty-one families and brings this section of the suborder Cyclorrhapha up to date. Seventy-nine of the species appear to be endemic to the Hawaiian Islands. The volume incorporates the results of our intensive field and laboratory studies, which have been conducted over the past twenty-five years. Much emphasis has been placed on host associations of endemic Tephritidae and on the aquatic Diptera, and important biological data have been accumulated on the families Canaceidae and Ephydriidae. The latter, and also the Sphaeroceridae, have been studied in detail by Dr. Joaquin Tenorio. Also, Mr. Steven L. Montgomery has obtained considerable information on the breeding habits and plant hosts of some of the species of Asteiidae. This is the first time, in any world literature, that biological data have been presented for these flies.

The introduced species have come in accidentally, mostly from Asia and the Pacific, except for some species purposely introduced for biological control of weeds, fresh water snails, mealy bugs, and aphids. Only four families (Tephritidae, Ephydriidae, Asteiidae, and Canaceidae) contain obviously endemic species and five others (Sphaeroceridae, Chyromyidae, Agromyzidae, Miliichiidae, and Tethinidae) contain species which are presently known only from Hawaii and which evidently are endemic.

The Acalyptratae are predominantly small flies characterized by the presence of a ptilinal suture on the head, lack of a complete transverse suture on mesonotum, lacking a longitudinal seam down posterodorsal surface of second antennal segment and lower calypter small or absent. The wing venation is rather uniform throughout the group and these flies usually lack lower fronto-orbital bristles or strong oral vibrissae. Many of the acalyptrates are notoriously difficult to identify: some of the family concepts have been ill defined; many families are still poorly known; and the taxonomic status of some has been chaotic. The earlier records of these flies in Hawaii have been replete with errors in identification and a large number of new species as well as new immigrant species have been recorded during the course of this study. Before we began our work only fifty-two species of acalyptrates, excluding Drosophilidae, had been recorded (Bryan, 1934) and a large share of these were errors.

The taxonomic arrangement of the families follows that of Colless and McAlpine (1970:719-731). This appears to be the most up to date treatment.

Previous to this volume approximately 1000 species of Diptera have been recorded from Hawaii. This now brings the present total up to 1200 species. The volume dealing with the calyptrate flies will add about 200 more, and with the 200-plus Drosophilidae and 100-plus Dolichopodidae, the total fauna will eventually number nearly 1700 species.

We have received a great deal of help on several of the more difficult families. Some of the scavenger flies especially, which have been so widely distributed by commerce, would have been impossible to treat without the help of specialists on the taxa involved. In some cases it has been necessary to do world reviews of some groups before the Hawaiian species could be correctly placed.

We are grateful to the following colleagues who were especially helpful to us in tracking down names, clarifying taxonomic problems, and getting together the information on the Hawaiian species: Brian H. Cogan, H. Oldroyd, K. A. Spencer, and O. W. Richards (London); J. F. McAlpine, G. E. Shewell, and J. R. Vockeroth (Ottawa, Canada); G. Steyskal, C. W. Sabrosky, L. V. Knutson, and W. W. Wirth (Washington); R. Dahl (Helsingborg, Sweden); M. R. Wheeler (Austin, Texas); and M. Sasakawa (Kyoto, Japan).

We thank Dr. Joaquin Tenorio, B. P. Bishop Museum, for the preparation of the Sphaeroceridae and Ephydriidae sections. These monographs were prepared as partial requirements for the Master of Science and PhD degrees in Entomology respectively and are valuable contributions to this volume. Also we thank Mr. George Steyskal, Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C., for preparing the description of *Sepedon oriens* n. sp.

Many people have helped us with the field work. Colleagues from the Entomology staff and graduate students at the University, and personnel of the B. P. Bishop Museum, State Department of Agriculture, U.S. Public Health Service, and State Board of Health have all made valuable contributions to this study.

We consider the artwork one of the most important aspects of this volume and we are very appreciative of the excellent illustrations which have been done. The whole drawings were prepared by Mr. Arthur Smith, British Museum (Natural History)—these are truly works of art. The other drawings have been prepared over the years by Geraldine Oda, Jocelyn Izu, Dennis Morihara, Roanne Tsutsui, Camille Wong, and Jack Grubb.

The manuscript typing was done by Mrs. Deanna R. Espinas and much assistance with collections and arrangement of plates and proofreading of manuscript was given us by Miss Linden Teramoto and Miss Anita Chan.

This study was made possible by the support given us for the Diptera of Hawaii by the National Science Foundation under grant GB 28603. Also, some of the field data on species which breed in association with native Drosophilidae were supported by GB 29288 and some of the investigation of the aquatic and litter-inhabiting fauna were supported by GB 23230.

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CHECKLIST OF THE INSECTS IN THIS VOLUME

Order DIPTERA

Suborder CYCLORRHAPHA

Series SCHIZOPHORA

Section ACALYPTERAE

Superfamily TEPHRITOIDEA							
Family OTITIDAE							
Subfamily OTITINAE							
Genus Acrostica Loew apicalis (Williston)	x	x	x	x	x	x	Widespread tropical America and Pacific, Ghana
Genus Ceroxys Macquart latiusculus (Loew)					x	x	Samoa, Western U.S., and Mexico
Genus Notogramma Loew cimiciforme Loew		x			x		Southern U.S., tropical America, Mariana and Caroline Is.
Subfamily ULIDIINAE							
Genus Euxesta Loew annonae (Fabricius)	x	x	x	x	x	x	Throughout subtropical and tropical America, Pacific
wettsteini Hendel	x		x	x	x		Neotropical region
Genus Physiphora Fallén aenea (Fabricius)	x	x	x	x	x	x	Asia, Australia, North and South America including Mexico
Genus Pseudeuxesta Hendel prima (Osten Sacken)						x	Celebes, widespread Pacific
Family PLATYSTOMATIDAE							
Genus Scholastes Loew bimaculatus Hendel	x	x	x	x	x	x	Fiji, Samoa, Society Is., Ellice Is., New Britain, New Hebrides
Family TEPHRITIDAE							
Subfamily DACINAE							
Genus Dacus Fabricius Subgenus Bactrocera Macquart dorsalis Hendel	x	x	x	x	x	x	Oriental region, Micronesia
Subgenus Zeugodacus Hendel cucurbitae Coquillett	x	x	x	x	x	x	Oriental region, China, Japan, Ryukyu Is., E. Africa, Mauritius, Pacific islands
Subfamily OEDASPINAE							
Genus Procecidochares Hendel alani Steyskal utilis Stone	x x	 x	 x	 x	 x	 x	Mexico Mexico, New Zealand

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subfamily TEPHRITINAE							
Tribe TEPHRELLINI							
Genus Xanthaciura Hendel connexionis Benjamin		*			*		Florida, Mexico
Tribe TEPHRITINI							
Genus Acinia Robineau-Desvoidy picturata (Snow)	x	x	x	x	x	x	Widespread over U.S., Mexico, West Indies, Wake and Johnston Is.
Genus Dioxyna Frey sororcula (Wiedemann)			x		x		Tropicopolitan
Genus Ensina Robineau-Desvoidy sonchi (Linnaeus)					x		Europe, Asia, Philippines
Genus Eutreta Loew xanthochaeta Aldrich	x	x	x	x	x	x	Mexico, Central America
Genus Neotephritis Hendel nigripilosa n.sp.		x					
paludosae n.sp.		x					
Genus Phaeogramma Grimshaw hispida n.sp.		x			?		
vittipennis Grimshaw			x				
Genus Tetreuaresta Hendel obscuriventris (Loew)		x			x	x	Neotropics, Fiji
Genus Trupanea Schrank apicalis n.sp.	x						
arboreae n.sp.	x						
artemisiae n.sp.		x					
beardsleyi n.sp.		x					
bidensicola n.sp.						x	
celaenoptera n.sp.	x						
crassipes (Thomson)	x	x	x	x	x		
cratericola (Grimshaw)		x					
dempta n.sp.	x						
denotata n.sp.		x					
dubautiae (Bryan)		x			x	x	
joycei n.sp.		x	x		x		
limpidapex (Grimshaw)		x					
lipochaetae n.sp.					x		
marginalis n.sp.	x						
megaspila n.sp.	x						
nigripennis n.sp.	x						
pantosticta n.sp.	x						
pekeloi n.sp.			x				
perkinsi n.sp.						x	
swezeyi (Byran)		x			x	x	
Subfamily TRYPETINAE							
Tribe CERATITINI							
Genus Ceratitis Macleay capitata (Wiedemann)	x	x	x	x	x	x	Ethiopian and Neotropical regions, Florida, Mauritius, Australia

*Throughout this checklist an asterisk is used to indicate that the species is not known to be established.

Superfamily SCIOMYZOIDEA Family SEPSIDAE	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Sepsis Fallén							
biflexuosa Strobl	x	x	x		x	x	Europe, Canary Islands, N. America, Canada, Mexico
lateralis Wiedemann					x		Palaeartic, Ethiopian, and Oriental regions
thoracica Robineau-Desvoidy		x	x		x		Palaeartic, Ethiopian, and Oriental regions
Family SCIOMYZIDAE							
Subfamily SCIOMYZINAE							
Tribe SCIOMYZINI							
Genus Atrichomelina Cresson							
pubera (Loew)	*				*	*	Mexico, Canada, U.S.
Genus Pherbellia Robineau-Desvoidy							
dorsata (Zetterstedt)					*		Europe, Siberia
parallela Walker	*				*	*	Nearctic
Tribe TETANOCERINI							
Genus Dictya Meigen							
abnormis Steyskal					*		Mexico
Genus Sepedomerus Steyskal							
macropus (Walker)	x	x			x	x	Texas, Mexico, Caribbean, Neotropical region
Genus Sepedon Latreille							
aenescens Wiedemann	x	x	x		x	x	Oriental region including Ryukyu Is., S. China, S. Korea, E. Iran, Tibet and S. and S.W. USSR
noteoi Steyskal							China, Taiwan
oriens Steyskal n.sp.	*	*	*		*	*	China, Japan, and Philippines
pacifica Cresson		*					Western U.S., western Canada, Baja California del Norte, Mexico
plumbella Wiedemann					*	*	Oriental region, Ryukyu Is., Hong Kong, New Guinea, New Caledonia, Solomon Is., E. Australia
praemiosa Giglio-Tos	*				*	*	Mexico, S.W. United States
senex Wiedemann	*						Oriental region including S.E. China
Family CHAMAEMYIIDAE							
Genus Leucopis Meigen							
Subgenus Leucopis Meigen							
albipuncta Zetterstedt	x	x			x		Holarctic, Kahoolawe
ocellaris Malloch					x		Nearctic
Subgenus Neoleucopis Malloch							
nigraluna McAlpine	x						India, Pakistan
obscura Haliday		x					Europe
Family LAUXANIIDAE							
Genus Homoneura van der Wulp							
hawaiiensis (Grimshaw)	x	x	x	x	x	x	Marquesas, Samoa, Society and Solomon Is.

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
postmacula (Walker)					*		Fiji Is.
striatifrons (de Meijere)		*					Java
unguiculata (Kertész)	x	x	x	x	x	x	Formosa
Superfamily HELEOMYZOIDEA							
Family SPHAEROCERIDAE							
Genus Copromyza Fallén							
Subgenus Copromyza Fallén							
equina Fallén	x	x	x			x	Europe, N. America
Subgenus Borborillus Duda							
sordida Zetterstedt	x	x	x		x	x	Kahoolawe, Europe, Africa, N. America, India
Genus Leptocera Olivier							
Subgenus Coproica Rondani							
acutangula (Zetterstedt)					x	x	Europe, Madeira, Belgian Congo, N. America
ferruginata (Stenhammar)					x		Cosmopolitan
hirtula (Rondani)	x		x		x	x	Cosmopolitan
vagans (Haliday)					x		Cosmopolitan
Subgenus Leptocera Olivier							
abdominiseta Duda	x	x	x	x	x	x	S. America
Subgenus Limosina Macquart							
bifrons (Stenhammar)	x	x	x		x	x	Cosmopolitan
brevicostata (Duda)	x	x	x		x	x	Europe
brevivenosa Tenorio	x	x			x	x	
empirica (Hutton)		x					Europe, Iceland, Canada, Juan Fernandez Is., New Zealand, Falkland Is., Campbell Is.
heteroneura (Haliday)	x				x	x	Formosa, Europe, Africa, N. America
mirabilis (Collin)	x	x	x		x	x	Europe, N. America
rufifrons Duda					x		Formosa, New Guinea, Abyssinia, E. India, Congo, Micronesia
Subgenus Opacifrons Duda							
aequalis (Grimshaw)	x	x	x	x	x	x	
Subgenus Pachytarsella Richards							
pachypus Richards					x		New Guinea
Subgenus Poecilosomella Duda							
punctipennis (Wiedemann)	x	x	x	x	x	x	Laysan Is., cosmopolitan
Subgenus Rachispoda Lioy							
downesi Richards		x			x	x	Laysan Is., Midway Is., Micronesia, N. America, Scotland
Subgenus Thoracochaeta Duda							
brachystoma (Stenhammar)	x	x			x		Lisiansky Is., Laysan Is., Midway Is., cosmopolitan
Subgenus Trachyopella Duda							
atomus (Rondani)		x		x	x		Micronesia, Europe, Canary Is., Madeira, Belgian Congo
hardyi Tenorio	x			x	x		Micronesia
obliqua Richards					x		Micronesia

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Family CHYROMYIDAE							
Genus Aphaniosoma Becker							
macalpinei n.sp.			x		x		
minuta n.sp.					x		Florida?
Genus Gymnochiromyia Hendel							
hawaiiensis n.sp.	x	x			x		
Superfamily OPOMYZOIDEA							
Family LONCHAEIDAE							
Genus Lamprolonchaea Bezzi							
metatarsata (Kertész)	x	x			x	x	Pacific, Indo-Australian region
Genus Lonchaea Fallén							
polita Say	x	x			x		U.S., Canada
striatifrons Malloch	x	x	x	x			Southwestern U.S., Mexico
Family PIOPHILIDAE							
Genus Piophila Fallén							
casei (Linnaeus)	x	x	x	x	x	x	Cosmopolitan
Genus Protopiophila Duda							
australis Harrison					x		Australia, Fiji
Family AGROMYZIDAE							
Subfamily AGROMYZINAE							
Genus Melanagromyza Hendel							
splendida Frick	x	x			x	x	Jamaica, Florida, California
Genus Ophiomyia Braschnikov							
cornuta (de Meijere)‡							Pacific, Canton Is., Caroline Is., Fiji, Indonesia, Indian Ocean
lantanae (Froggatt)	x	x	x	x	x	x	Orient, Australia, Africa, Southern U.S., Central America, Mexico
nealae Sasakawa					x		
phaseoli (Tryon)	x	x	x		x	x	Tropics, subtropics of world, Africa, S. Asia, N. Australia, Pacific
simplex (Loew)					x		N. America, Europe
n.sp. Sehgal in manuscript					x		
Subfamily PHYTOMYZINAE							
Genus Amauromyza Hendel							
maculosa (Malloch)	x		x	x	x	x	N. America, Neotropical region
Genus Calycomyza Hendel							
humeralis (Roser)					x		Midway and Kure Is., nearly cosmopolitan
Genus Liriomyza Mik							
brassicae (Riley)	x	x	x	x	x	x	Cosmopolitan
cocculi (Frick)	x	x	x	x	x	x	Southern half of Nearctic region

‡Possibly present in Hawaii.

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
huidobrensis (Blanchard)					x	x	Western N. America and Neotropical region
sativae Blanchard	x	x	x	x	x	x	Widespread over N. America, West Indies
Genus Phytoliriomyza Hendel							
montana Frick	x	x	x	x	x	x	
Genus Phytomyza Fallén							
plantaginis Robineau-Desvoidy	x	x	x			x	Nearctic, Palaearctic, Formosa, Australia
Genus Pseudonapomyza Hendel							
spicata (Malloch)	x	x	x		x	x	Nihoa, Kure Is., widespread over Pacific and Oriental regions
spinosa Spencer		x					Africa, Australia, Micronesia, Samoa
Superfamily ASTEIOIDEA							
Family AULACIGASTRIDAE							
Genus Stenomicroa Coquillett							
orientalis Malloch	x				x		
Family ANTHOMYZIDAE							
Genus Amygdalops Lamb							
thomasseti Lamb	x		x		x	x	Seychelles
Genus Mumetopia Melander							
nigrimana (Coquillett)	x		x	x	x		Florida, Neotropical region
Family ASTEIIDAE							
Genus Asteia Meigen							
aberrans n.sp.							Northwest Hawaiian Islands, Nihoa and Necker
apicalis Grimshaw	x	x					
hawaiiensis Grimshaw	x						
mauiensis n.sp.		x					
molokaiensis n.sp.			x				
montgomeryi n.sp.	x						
nudiseta Sabrosky					x		
palikuensis n.sp.		x					
sabroskyi n.sp.	x	x	x		x	x	
Genus Bryania Aldrich							
bipunctata Aldrich							Northwest Hawaiian Islands, Nihoa, Laysan, Kure
Genus Loewimyia Sabrosky							
orbiculata n.sp.					x		
Superfamily DROSOPHILOIDEA							
Family EPHYDRIDAE							
Subfamily PSILOPINAE							
Tribe GYMNOPIINI							
Genus Chlorichaeta Becker							
albipennis (Loew)	x				x	x	Europe, Africa

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Mosillus Latreille							
grandis (Cresson)					x		Formosa, Pacific
tibialis Cresson		x	x		x		Nearctic, Neotropical regions
Genus Placopsidella Kertész							
cynocephala Kertész	x				x	x	Oriental, Pacific, Australasian regions
Tribe ATISSINI							
Genus Atissa Haliday							
antennalis Aldrich	x	x			x	x	Nihoa Is., Necker Is.
oahuensis Cresson					x		
Genus Hecamede Haliday							
persimilis Hendel	x	x	x		x	x	Formosa, Pacific
Genus Nannodastia Hendel							
horni Hendel					x		Formosa, West Indies
Tribe DISCOCERININI							
Genus Discocerina Macquart							
mera Cresson	x				x		Formosa, Fiji, Guam, Palmyra
Genus Hostis Cresson							
guamensis Cresson		x			x		Guam, Palmyra
Genus Paratissa Coquillett							
semilutea (Loew)		x			x		Cuba, Florida, Bermuda, West Indies, Panama
Tribe DISCOMYZINI							
Genus Discomyza Meigen							
maculipennis (Wiedemann)					x		East Indies, California, Neotropical, Oriental, Australasian, Pacific, Lisiansky Is.
Tribe PSILOPINI							
Genus Ceropsilopa Cresson							
coquilletti Cresson	x	x	x	x	x	x	Nearctic, Neotropical region, Formosa, Guam, Philippines
Genus Clasiopella Hendel							
uncinata Hendel	x		x		x		Midway Is., Australasian and Ethiopian regions
Genus Psilopa Fallén							
olga Cresson	x	x			x	x	Nearctic, Formosa
Subfamily NOTIPHILINAE							
Tribe ILYTHEINI							
Genus Donaceus Cresson							
nigronotatus Cresson	x	x			x	x	Oriental, New Guinea
Tribe HYDRELLINI							
Genus Hydrellia Robineau-Desvoidy							
hawaiiensis Cresson	x				x		
williamsi Cresson	x				x		Australia, New Zealand
Tribe NOTIPHILINI							
Genus Notiphila Fallén							
insularis Grimshaw	x		x		x	x	

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subfamily PARYDRINAE							
Tribe HYADINI							
Genus Brachydeutera Loew							
hebes Cresson	x	x	x		x	x	Kahoolawe Is.
Genus Hyadina Curtis							
vittifacies n.sp.					x		
Genus Lytogaster Becker							
gravida (Loew)	x	x	x		x	x	Nearctic, Mexico
Subfamily EPHYDRINAE							
Tribe EPHYDRINI							
Genus Ephydra Fallén							
cinerea Jones					x	x	Nearctic, Mexico, West Indies
milbrae Jones		x			x		California
Tribe SCATELLINI							
Genus Apulvillus Malloch							
cinereifacies n.sp.						x	
femoralis n.sp.		x					
mauiensis Wirth	x†	x	x†				
williamsi Wirth	x						
Genus Neoscatella Malloch							
amnica n.sp.	x	x	x				
bryani (Cresson)	x	x	x	x	x	x	
cilipes Wirth	x†	x†	x†		x	x	
clavipes Wirth	x	x†	x†		x	x†	
fluvialis n.sp.	x				x		
hawaiiensis (Grimshaw)	x	x	x	x†	x	x	
kauaiensis Wirth						x	
oahuense (Williams)	x	x		x†	x	x	
sexnotata (Cresson)	x	x	x		x	x	Wake Is., Leeward Hawaiian Is.
terryi (Cresson)					x		
warreni (Cresson)	x	x	x†		x	x†	
Genus Scatella Robineau-Desvoidy +							
stagnalis (Fallén)	x†				x†		Cosmopolitan
wirthi n.sp.	x	x					
Family MILICHIIDAE							
Subfamily MADIZINAE							
Genus Desmometopa Loew							
inaurata Lamb	x	x	x	x	x	x	Seychelles
singaporensis Kertész	x				x		Singapore
tarsalis Loew	x	x	x	x	x	x	Cuba
tristricula Hendel					x	x	West Indies, Panama, Nearctic
Genus Leptometopa Becker							
beardsleyi n.sp.							Lisianski, Nihoa, and Necker Is.
Genus Neophyllomyza Melander							
sp.?					x		Pearl and Hermes Atoll

†New Island record.

+ New immigrant.

CHECKLIST

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	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subfamily MILICHIINAE							
Genus Milichia Meigen orientalis Malloch	x				x		Guam, Nihoa, Necker Is., Gardner Is.
Genus Milichiella Giglio-Tos circularis Aldrich lacteipennis (Loew)	x	x	x	x	x	x	Worldwide including all leeward Hawaiian Islands
longiseta n.sp.					x		
Family CRYPTOCHETIDAE							
Genus Cryptochetum Rondani iceryae (Williston)	x				x	x	Australia, New Zealand, California
Family TETHINIDAE							
Genus Dasyrhicnoessa Hendel insularis (Aldrich)	x	x			x		French Frigate Shoals, Pearl and Hermes Atoll, Palmyra and Canton Is.
vockerothi n.sp.	x		x		x		
Genus Pelomyia Williston steyskali n.sp.			x		x		California, Oregon, Texas, Washington
Genus Tethina Haliday variseta (Melander)	x	x			x	x	Kahoolawe, French Frigate Shoals, California
Family CANACEIDAE							
Genus Canaceoides Cresson angulatus Wirth	x	x	x		x	x	Laysan, Lisianski, Wake, Midway, Baja California, Mexico, Peru, Galapagos, Gulf of California
hawaiiensis Wirth	x	x	x		x	x	Nihoa
Genus Procanace Hendel acuminata n.sp.	x		x		x		
bifurcata n.sp.					x	x	
confusa n.sp.	x	x	x				
constricta n.sp.	x	x	x				
nigroviridis Cresson						x	
quadrisetosa n.sp.						x	
williamsi Wirth					x		Japan
wirthi n.sp.					x	x	
unnamed sp.	x						
Family CHLOROPIDAE							
Subfamily CHLOROPINAE							
Genus Chloropsina Becker citrivora Sabrosky	x		x		x		
Genus Neoloxotaenia Sabrosky gracilis (de Meijere)					x	x	Formosa, Java, Sumatra, Philippines

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus Semarangia Becker dorsocentralis Becker					x		Africa, Oriental region, USSR (Maritime Territory)
Genus Thaumatomyia Zenker glabra (Meigen)	x						Palaeartic, N. Mexico
Subfamily OSCINELLINAE							
Genus Cadrema Walker pallida (Loew)	x	x	x	x	x	x	Palmyra Is., Tropicopolitan
Genus Gaurax Loew bicoloripes (Malloch)		x			x	x	Palmyra Is., Marquesas
Genus Hippelates Loew collusor (Townsend)							Kure Is.?, Mexico, southwestern U.S.
hermsi Sabrosky		x	x	x	x		N. Mexico, southwestern U.S.
Genus Monochaetoscinella Duda anonyma (Williston)	x	x	x	x	x	x	Widespread over U.S., and Neotropical region
Genus Oscinella Becker formosa Becker	x	x			x	x	Formosa, Micronesia, southern U.S., Neotropics
Genus Meijerella Sabrosky flavisetosa Sabrosky	x	x	x		x	x	Malaysia, Mariana, and Bonin Is.
Genus Rhodesiella Adams elegantula (Becker)	x				x	x	Formosa, Java, Philippines
sauteri (Duda)					x		Formosa
scutellata (de Meijere)	x	x	x	x	x	x	Oriental region, New Guinea
Genus Siphunculina Rondani striolata (Wiedemann)		x			x		Leeward Hawaiian Is., widespread in tropics

Family OTITIDAE
Picture-winged Flies

Medium-sized flies which are readily recognized by the predominantly pictured wings, by the wing venation, and by their distinctive behavior. Members of this family are often confused with Tephritidae and in some aberrant genera the two families almost intergrade. For the most part, and certainly in all of the Hawaiian species, the distinction between the two families is very marked. The bristling of the front and pleura and the difference in wing venation will readily separate these. Otitidae have no lower fronto-orbital bristles and no pteropleural bristles; also the costa is complete with no indication of a break just before end of vein R_1 and the subcostal vein is gently curved into the costa (fig. 1a) rather than bending at a right angle before entering the costa as in Tephritidae.

The larvae are predominantly scavengers, living mostly in rotting vegetation. The habit of "wing waving" is rather common in this family.

Only seven species, in six genera, occur in Hawaii; these are all introduced and fit into two subfamilies: Ulidiinae and Otitinae.

KEY TO HAWAIIAN OTITIDAE

1. Vein R_1 bare. Arista bare. Propleural bristle tiny, seta-like, about equal in size to the propleural hairs. Face lacking prominent antennal grooves. 2
 - Apical one-third to two-fifths of R_1 haired above. Arista pubescent. Propleural bristle strong, two-thirds to three-fourths as long as the humeral bristle. Face with elongate grooves in which the antennae fit (fig. 2b). **Ceroxys latiusculus** (Loew).
- 2(1). Body metallic blue-green. Cell R_5 closed and petiolate (fig. 6c). **Physiphora aenea** (Fabr.).
 - Not as above. Cell R_5 open. Front pitted or strongly wrinkled. 3
- 3(2). Mesonotum black, with an intricate pattern of longitudinal gray lines (fig. 3f). Mesopleura gray, covered with black spots (fig. 3e). Vertex sharply angulate (fig. 3b). Wings spotted with brown, cell R_1 narrow (fig. 3c). Front strongly rugose (fig. 3a). **Notogramma cimiciforme** Loew.
 - Thorax entirely black in ground color, not spotted or marked with gray lines. Vertex rounded. Wings not spotted, cell R_1 rather broad. 4

- 4(3). Front slightly rugulose (fig. 1b). Wings brown to black along the anterior margin from the base to the apex of vein R_1 and with a brown spot at the apex (fig. 1a). **Acrostica apicalis** (Williston).
Front smooth. Wings not as above (figs. 4a, 5a, 7a). 5
- 5(4). Wings with four dark brown transverse bands (figs. 4a, 5a). Occiput narrow. Front with two irregular rows of long setae down sides (fig. 4b). **Euxesta** Loew 6
Wings with three brown spots on costal margin as in figure 7a. Occiput broad (fig. 7b). No lower fronto-orbital long setae present.
. **Pseudeuxesta prima** (Osten Sacken).
- 6(5). Face tinged metallic blue in ground color of lower portion. Subbasal band of wing scarcely expanded in second costal cell and filling about basal fourth of this cell (fig. 4a). Surstyli of male forked (fig. 4d); female ovipositor comparatively short, measuring about 2.0 mm. **annonae** (Fabr.).
Face rufous on lower third. Subbasal band extends through second costal cell over half its length (fig. 5a). Surstyli simple (fig. 5b) and female ovipositor 4.0 mm. long. **wettsteini** Hendel.

Subfamily OTITINAE

According to Steyskal's classification (1961:403), as modified from Hennig (1939), the members of this subfamily are differentiated by having the "aedeagus bristly or hairy (fig. 3d), more or less simple at tip; wing vein R_1 setulose apically (except in *Ulidiotites*, *Tujungo*, *Notogramma*, and some species of *Seioptera* and *Curranops*)."

Three Hawaiian genera belong here: in *Acrostica* Loew and *Notogramma* Loew vein R_1 is bare and in *Ceroxys* Macquart the vein is setose above on the apical $\frac{2}{3}$. Apparently the male genitalia provide the only reliable subfamily characters according to the present classification.

Genus ACROSTICA Loew

Acrostica Loew, 1868, Berl. Ent. Z. 11:293. Type-species, *acrobiculata* Loew, by designation of Coquillett (1910:503).

This genus is similar to *Notogramma* Loew but the vertex is rounded; cell R_1 is broader than R_3 ; the male aedeagus is much smaller and is inconspicuously short haired on sides of ventral margin, and other details differ as brought out in the description of the species.

Steyskal (1952:278, and 1961:403) placed this in the subfamily Ulidiinae, but because of the presence of fine hairs along sides of venter of the aedeagus and its close resemblance to *Notogramma*, it would seem best to place it in Otitinae. In his review of *Notogramma* Loew, Steyskal (1963a:195) said that "the generic distinctions in the Ulidiinae, especially between the genera *Notogramma* Loew, *Acrosticta* Loew, *Euxesta* Loew [et al.] . . . should be reviewed."

Only one species occurs in Hawaii.

***Acrostica apicalis* (Williston) (figs. 1a-e)**

Euxesta apicalis Williston, 1896, Trans. Ent. Soc. Lond. 1896:375, pl. 12, fig. 128. Type-locality: St. Vincent Island.

Common in the lowlands and probably present on all of the main Hawaiian islands.

Immigrant. Widespread over tropical America, Florida, over the Pacific, and Ghana (Africa). It was first recorded in Hawaii by Grimshaw (1901:44) from specimens collected in 1895 and 1896 on Kauai and Hawaii.

Malloch reported specimens from the Bahamas which had been reared from larvae feeding in yams. This species obviously breeds in decaying plant matter but no observations of its habits have been made in Hawaii.

This species fits nearest to *Notogramma cimiciforme* Loew but is readily differentiated by the rounded vertex (fig. 1c); by the lack of gray vittae or spots on the body; the broad cell R_1 and very different wing markings (fig. 1a); as well as by the more finely ruggose front, the very different genitalia, and by other details noted below and in the figures.

A rather small species which has the body almost entirely metallic black, covered with gray pollen, and with a characteristic brown transverse band extending across the mesonotum at a level with the suture. The front is predominantly rufous, gray pollinose along the eye orbits, and finely ruggose as in figure 1b. The profile view of the head is as in figure 1c. The wings are hyaline except for a spot of brown at apex and brown coloration along the costa to apex of vein R_1 . Cell R_1 broader than cell R_3 and venation is as in figure 1a. Front coxae, femora, and middle and hind basitarsi yellow to rufous. Legs, otherwise black, slightly tinged with red. The genitalia of both sexes are as in figures 1d and 1e. Male surstyli slender, tapered, and incurved; aedeagus with short hair along the sides. Female with two pear-shaped spermathecae.

Length: body, 3.9-4.3 mm.; wings, 3.2-3.6 mm.

Genus CEROXYS Macquart

Meckelia Robineau-Desvoidy, 1830, Mém. Présentes Acad. R. Sci. Inst. Fr. 2:714 (preocc. Leuckart, 1828). Type-species, *Oscinis elegans* Robineau-Desvoidy, by subsequent designation (Coquillett, 1910:564), = *hortulanus* (Rossi).

Ceroxys Macquart, 1835, Hist. Nat. Ins. Dipt. 2:437. Type-species, *Musca urticae* Linnaeus, by subsequent designation (Westwood, 1810:149).

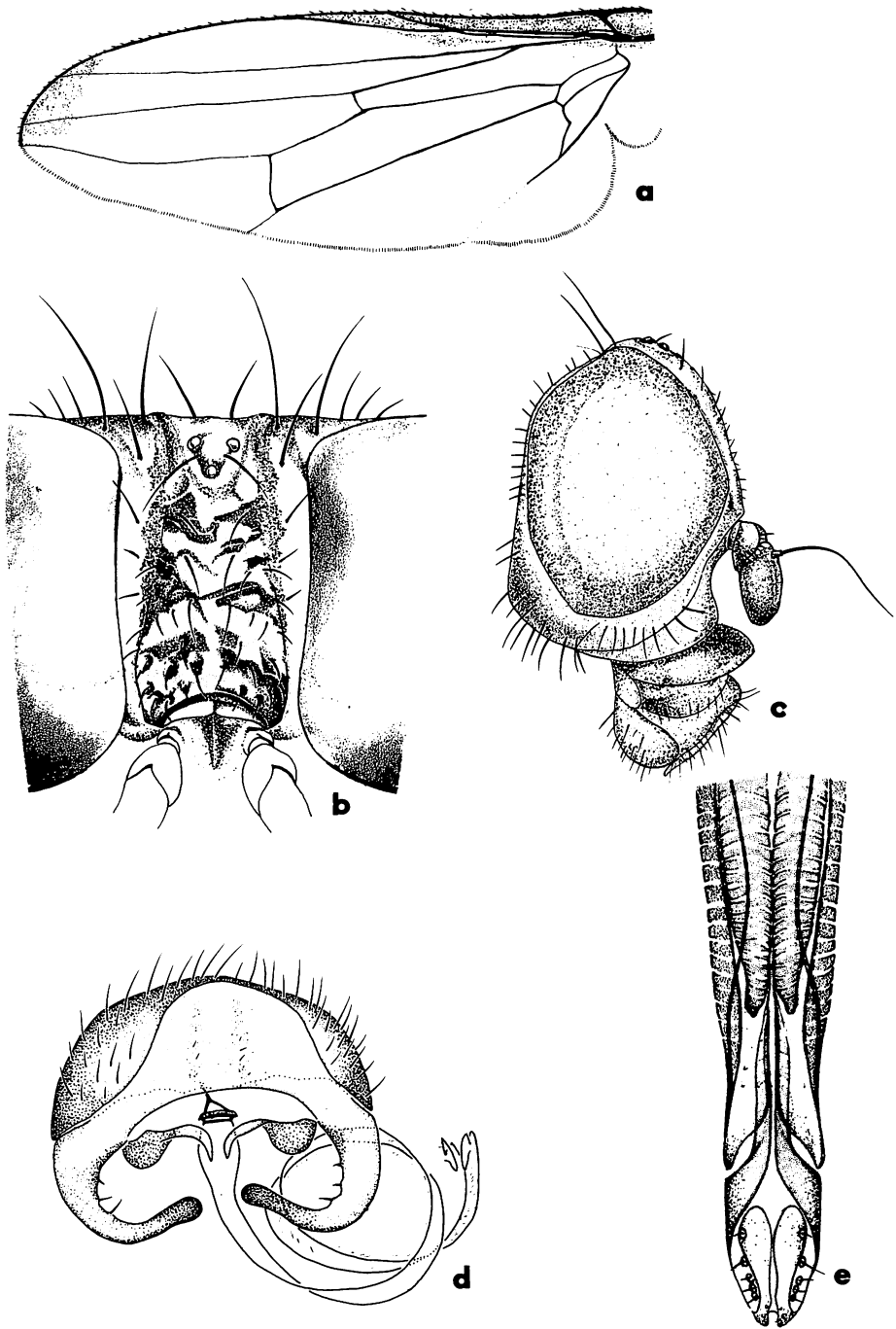


Figure 1—*Acrostica apicalis* (Williston): a, wing; b, head, front view; c, head, lateral view; d, male genitalia, end view; e, apex of female ovipositor.

Ceratoxys Rondani, 1861, Dipterol. ital. Prodr. 4:10 (new name for *Meckelia* Robineau-Desvoidy). Type-species, *Oscinis elegans* Robineau-Desvoidy, automatic, = *hortulanus* (Rossi).

Anacampta Loew, 1868, Z. Gesam. Naturw. 32:7. Type-species, *Musca urticae* Linnaeus, by subsequent designation (Loew, 1873:58).

***Ceroxys latiusculus* (Loew) (figs. 2a-e)**

Anacampta latiuscula Loew, 1873, Smithson. misc. Collns. 11:130.

Oahu and Kauai.

Immigrant. Common in western United States and Mexico, also Samoa.

Type-locality: "California." The type is in the Museum of Comparative Zoology, Cambridge.

First reported in Hawaii by Hardy (1956:11). It has obviously been

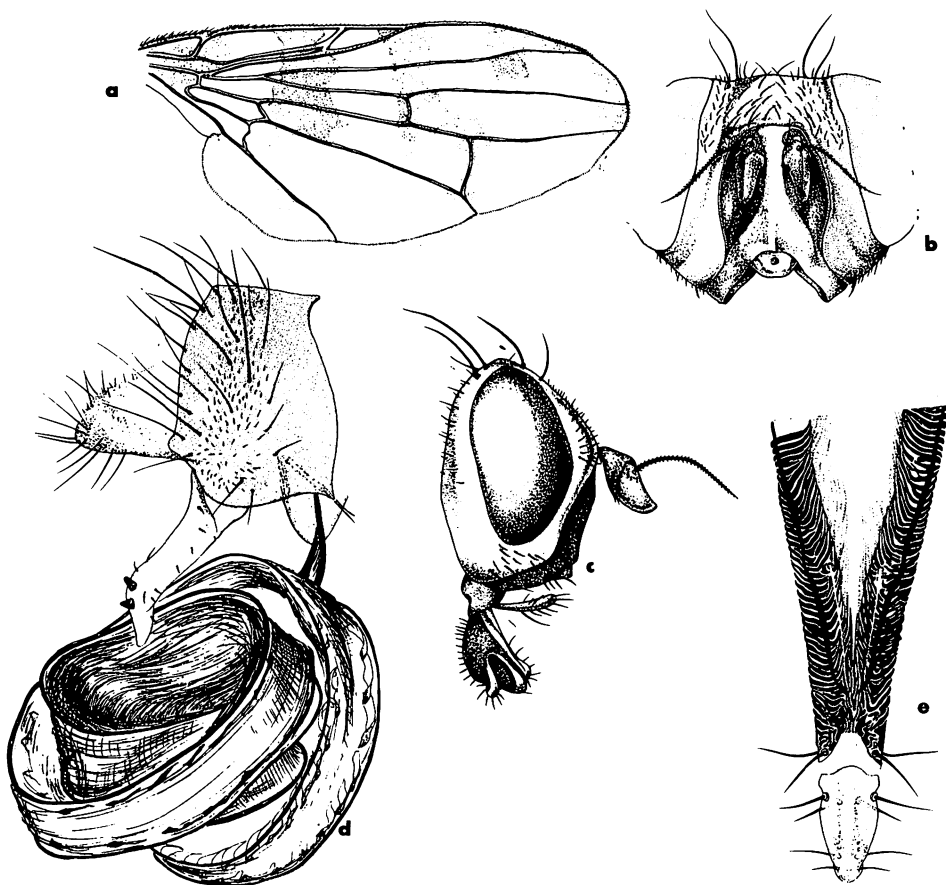


Figure 2—*Ceroxys latiusculus* (Loew): a, wing; b, head, front view; c, head, lateral; d, male genitalia; e, female ovipositor.

established here for many years and has been overlooked by the entomologists. The earliest record we have found is three specimens taken in a rice field at Pearl City, Oahu, February 27, 1928 (O. H. Swezey). This is without doubt the fly which Williams (1931:303-304) referred to as "an undetermined orlatid that looks like a large edition of *Euxesta annonae*." This "was taken for the first time on November 28, 1928, in the rice fields of Honouliuli, Oahu, by Mr. Swezey, and during 1929 was found in fields of small cane at Ewa, Oahu, and on the low cane lands of Kekaha, Kauai. It is probably a feeder in decaying vegetable matter." One specimen has been seen in the USDA Plant Quarantine collection from Samoa, collected "7-8-1948."

C. latiuscula is distinguished from other Otitidae in Hawaii by the subfamily and generic characters given above. The wing markings (fig. 2a) are also distinctive.

A moderately large species approximately the size of a house fly. The head and appendages are yellow to rufous, except for the red eyes. The third antennal segment is acute at apex; the arista is finely pubescent. The front is broad and densely setose (fig. 2b). The profile view of the head is as in figure 2c. The mesonotum is densely gray pollinose except for a small shining black spot at the base of each seta or bristle. The scutellum is yellow to rufous, tinged with brown to black on the disc. The humeri are yellow, faintly tinged with brown. Two pairs of dorsocentral bristles are present. The propleural bristle is two-thirds as long as the humeral. The legs are yellow, tinged with brown on the tibiae and tarsi. The wing markings and venation are as in figure 2a. Vein R_1 is setose above on the apical one-third to two-fifths. The abdomen is shining black except for a broad gray-white transverse band across the bases of terga three and four. The genitalia of both sexes are as in figures 2d, e. Three elongate, club-shaped spermathecae in female.

Length: body, 6.4-7.0 mm.; wings, 5.3-5.7 mm.

Genus **NOTOGRAMMA** Loew

Notogramma Loew, 1868, Berl. Ent. Z. 11:289. Type-species, *cimiciforme* Loew, by monotypy.

This genus resembles *Acrosticta* Loew but is differentiated by the sharply angulate vertex (fig. 3b); cell R_1 less than half as wide as R_3 (fig. 3c); and by the more strongly ruggose front (fig. 3a); by having the aedeagus of the male greatly enlarged, densely haired ventrally and with short thick spines on basal portion. Also, the body and wing markings are very different as discussed under the species.

For a review of this genus refer to Steyskal (1963).

Only one species is represented in Hawaii.

Notogramma cimiciforme Loew (figs. 3a-h)

Notogramma cimiciforme Loew, 1868, Berl. Ent. Z. 11:289. Type-locality: Cuba. *Stigma* of authors, not Fabricius.

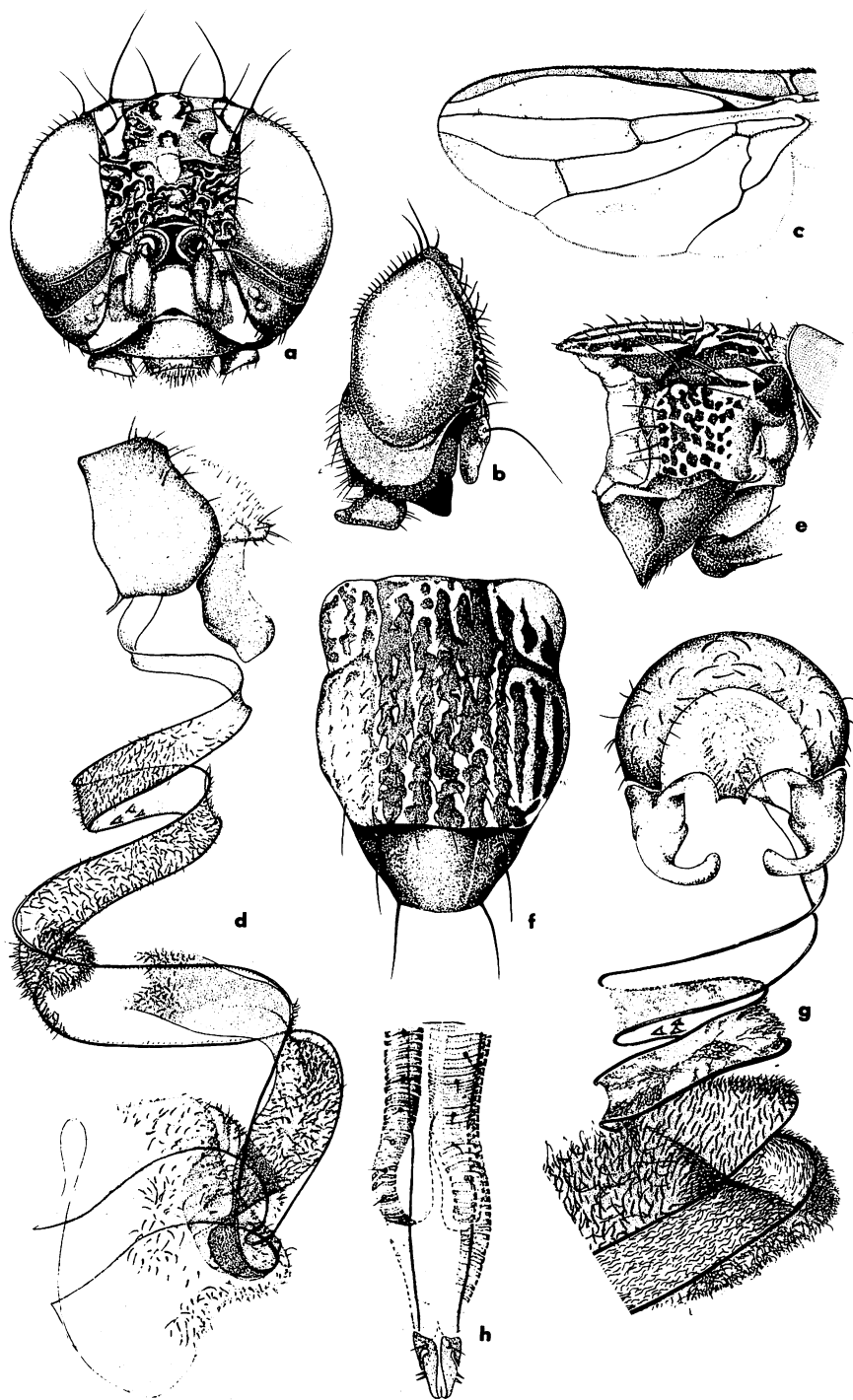


Figure 3—*Notogramma cimiciforme* Loew: a, head, front view; b, head, lateral; c, wing; d, male genitalia, lateral; e, thorax, lateral; f, thorax, dorsal; g, male genitalia, end view; h, female ovipositor.

Oahu, Maui and probably on all of the main islands. Previously recorded under the name *stigma* (Fabricius).

Immigrant. Widespread over the southern United States and American tropics and has been recorded from the Mariana and Caroline islands.

This species was first recorded in Hawaii in 1912 by Severin and Hartung (1912:448), bred from decaying bananas. Knab (1916:41) said a specimen received from Mr. Swezey "bears the label Honolulu, March 2, 1907." Swezey (1914a:4) reared this from decaying fruits. Knab (*loc. cit.*) recorded it having been bred from *Solanum*, "presumably the fruit," in Texas and from fruits of a Palm, *Attalea*, in Panama. Steyskal (1963:198) said "the species has been reared from rotting tomatoes, immature coconuts, bananas, liver, wild tuber, *Solanum* fruits and fruits of *Attalea* palms."

This species is easily separated by the ruggose front (fig. 3a); the angulate vertex (fig. 3b); the distinctive gray and black pattern of the mesonotum (fig. 3f) and the black spots on the mesopleura (fig. 3e); by the narrow cell R_2 and the wing venation and markings as in figure 3c; and by the characteristics of the male and female genitalia as shown in figures 3d, g, h. Surstyli simple, curved inwards, aedeagus greatly enlarged, arranged in a coil and densely haired. The female has two rounded spermathecae. The legs are black except for the yellow basitarsi. Steyskal (1963:196) differentiates *cimiciforme* from other species of the subgenus *Notogramma* by having the "mesopleura pale pruinose with pattern of dark dots, brown costal border of wing not interrupted; male aedeagus with a few small teeth in midsection; aedeagal apodeme simple, without apical arms or anterior shelf."

Length: body, 3.6–4.6 mm.; wings, 2.7–3.6 mm.

Subfamily ULIDIINAE

According to Steyskal (1961:403) the members of this subfamily are characterized by having the "aedeagus bare, sometimes with specialized end structure; wing vein R_1 bare (except in *Homalocephala*, some species of *Euxesta* and *Acrostica*, and in the extralimital *Paraeuxesta* and *Neoeuxesta*). On the basis of the male aedeagus we are placing *Acrostica* Loew under Otitinae.

Three Hawaiian genera and four species, belong here: *Euxesta* Loew, *Physiphora* Fallén, and *Pseudeuxesta* Hendel.

Genus EUXESTA Loew

Euxesta Loew, 1868, Berl. Ent. Z. 11:297. Type-species, *Ortalis notata* Wiedemann, by designation of Coquillett (1910:543).

Aloceuxesta Hendel, 1936, Annls naturh. Mus. Wien 47:78. Type-species, *Euxesta spoliata* Loew, by original designation.

Euxestina Enderlein, 1937, Sber. Ges. naturf. Freunde Berl. 1936:438 (preocc. Curran, 1934). Type-species, *Musca costalis* Fabricius, by original designation.

Two species occur in Hawaii. For key to species of *Euxesta* refer to Curran (1935:10-13).

This genus differs from *Pseudeuxesta* (Osten Sacken) by the very narrow upper occiput (fig. 4b); also, the third costal section is about one-third as long as the second and the wing markings are distinctive in the Hawaiian species (figs. 4a, 5a). Steyskal (1952:279) keys this near *Perissoneura* Malloch but differentiates *Euxesta* by lacking a spur vein on the terminal section of vein $M_1 + 2$ and the propleural bristle being very fine and short. In his 1961 key (p. 405), Steyskal keys this near *Zacompsia* Coquillett and differentiates *Euxesta* by having the front at most as wide as an eye, the body color metallic, and prescutellar bristles present.

***Euxesta annonae* (Fabricius) (figs. 4a-d)**

Musca annonae Fabricius, 1794, Ent. Syst. 4:358. Type-locality: West Indies.

Urophora quadrivittata Macquart, 1835, Hist. Nat. Dipt. 2:456. Type-locality: Cuba.

Widespread throughout the lowlands on all of the main islands.

Immigrant. Common throughout tropical and subtropical America, it has also been recorded from Fiji, Guam, and the Philippine Islands, and is probably widespread throughout the Pacific region.

This species was first recorded in Hawaii by Grimshaw (1902:85) from one female "taken in Honolulu Mts., 1900." Williams (1931:303) said that this "was first recorded in 1892." *E. annonae* has been suspected of being a pest of sugar cane (Perkins, 1903:27) since it often breeds in galleries of the sugar cane borer (also in galleries of the rice borer), but, as pointed out by Williams (*loc. cit.*), it obviously breeds as a scavenger. It has been reported breeding in a variety of types of rotting organic matter: rotting bananas (Severin and Hartung, 1912:448; Fullaway, 1912:31; and Illingworth, 1926:30 and 1927:395); and hen manure (Illingworth, 1923a:272). Illingworth also noted that it is attracted to carrion (1923b:280), and considered it a minor pest of pineapples because it may transmit rot organisms to abrasions on the fruits (1929:255). Some of the records may pertain to *wettsteini* Hendel.

This species is similar in most respects to *wettsteini* Hendel and the two have been confused in the Hawaiian literature. Both have four dark brown bands across the wing, and metallic blue-black body covered with gray pollen. Vertex rounded and head profile as in figure 4b. Front largely rufous, gray along orbits, and with two irregular rows of strong setae along each side. Antennae rufous with third segment short and rounded and arista bare. Two pairs dorsocentral bristles, with anterior pair about half as long as posterior and situated opposite supraalars. Legs predominantly blue-black, rufous, tinged with brown to black on tibiae, tarsi, and apices of femora.

E. annonae is differentiated from *wettsteini* by having the face rufous, with a faint tinge of metallic extending over lower portion. Curran (1935:11) differentiated *annonae* from other *Euxesta* by having "the face reddish, with scarce-

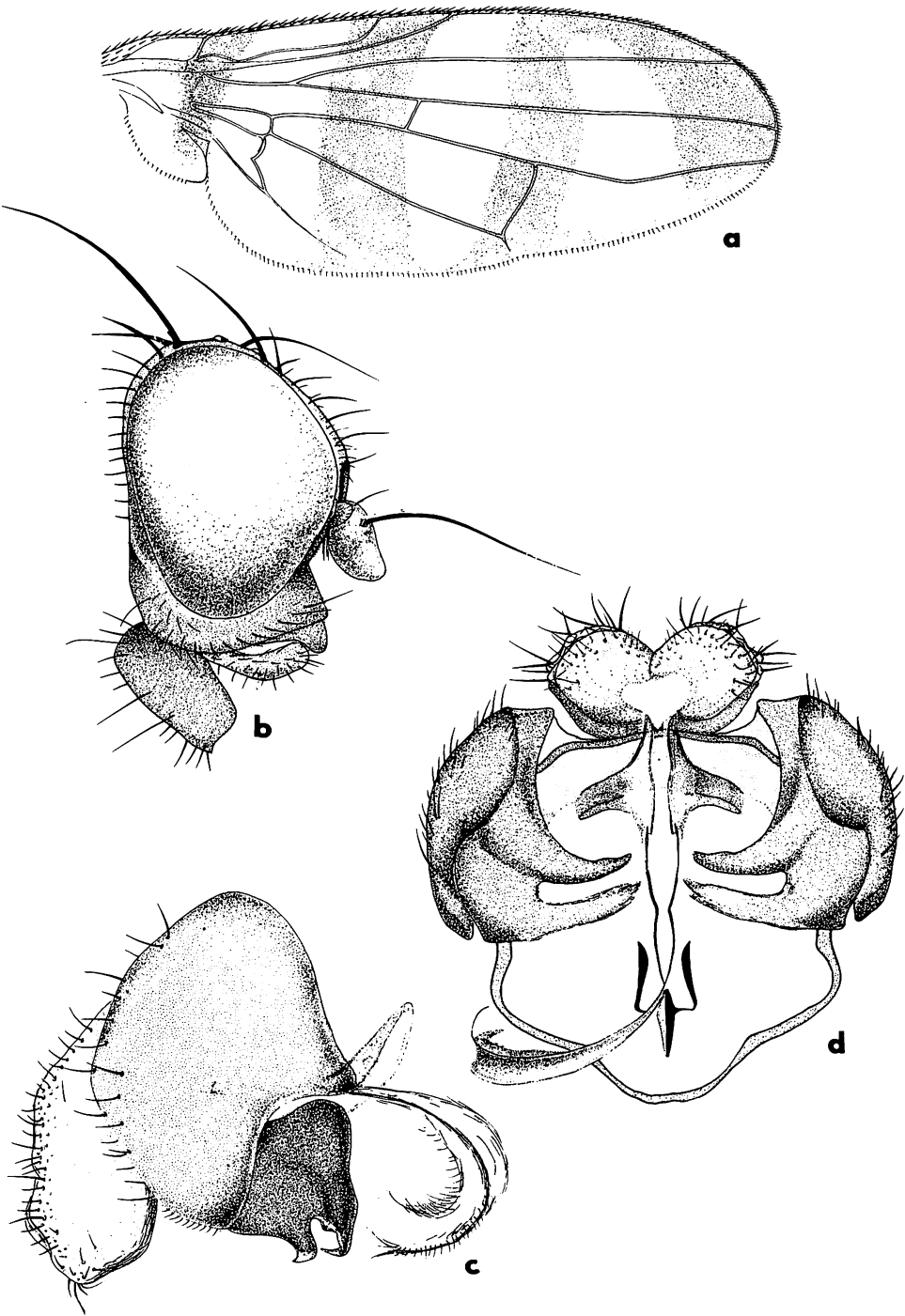


Figure 4—*Euxesta annonae* (Fabricius): a, wing; b, head, lateral; c, male genitalia, lateral; d, male genitalia, end view.

ly any metallic coloration." This character alone would not be reliable. The two are best separated by the wing markings and by the genitalia of both sexes. In *annonae* the crossbands on the wings evanesce along the posterior border. The subbasal band is scarcely expanded in second costal cell and fills about basal fourth of this cell; the two middle bands are almost straight sided (fig. 4a). The fifth sternum of male is as long as wide. The surstyli are forked and with a row of bristles along inner margin of lower lobe. Aedeagus short and stout, extending but a short way beyond surstyli (figs. 4c, d). The female ovipositor is comparatively short; the basal segment is as wide as long; and, as seen from above, is scarcely longer than the fifth tergum and measured on the venter about .50 mm. long. The piercer is blunt at apex, with two large and three small preapical setae on each side, and .75 mm. in length. The extended ovipositor measures 2.0 mm. Two large, rounded, spermathecae.

Length: body, 3.6–4.0 mm.; wings, 3.2–3.5 mm.

***Euxesta wettsteini* Hendel (figs. 5a–b)**

Euxesta wettsteini Hendel, 1909, Annls hist.-nat. Mus. Natn. hung. 7:165.

Type-locality: Iguape, Brazil. Type in Naturhistorisches Museum, Vienna.

Oahu, Molokai, Lanai, Hawaii, probably on all the main Islands.

Immigrant. Neotropical.

This species has been confused with *E. annonae* (Fabricius). It was apparently introduced into Hawaii prior to 1915; a specimen in the U.S. National Museum, from Kona, Hawaii was collected that year by Busck. George Steyskal, USDA, stated (pers. comm.) that this may possibly have been introduced with pineapple propagation material "since two of their specimens were taken on pineapple plants."

The species breeds in rotting vegetation.

E. wettsteini resembles *annonae* (Fabricius) (refer to discussion under that species) but differs by having lower one-third of face rufous, devoid of gray pollen and metallic blue sheen. The crossbands on the wings are continuous over hind margin; the subbasal band extends along costal margin over half the length of second basal cell, and the two median bands are expanded in posterior portion of wing (fig. 5a). Fifth sternum of male distinctly wider than long. Surstyli simple, long and curved (fig. 5b). The aedeagus much more slender and longer than in *annonae*. Ovipositor comparatively long; basal segment nearly two times longer than wide, equal in length to terga four + five and measuring 1.2 mm. on the venter. Piercer slender, rounded at apex, 1.5 mm. long. Extended ovipositor 4.0 mm. Two rounded spermathecae.

Steyskal (1969) has described this species.

Length: body, 4.7 mm.; wings, 4.0 mm.

Genus *PHYSIPHORA* Fallén

Physiphora Fallén, 1810, Specim. Ent. nov. Dipt.:11. Type-species, *Chrysomya splendida* Fallén, automatic, = *demandata* (Fabricius).

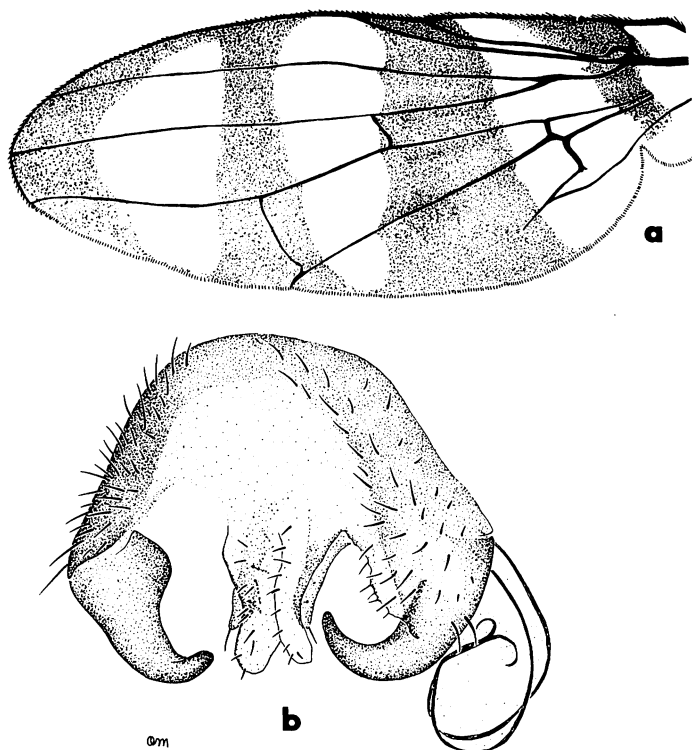


Figure 5—*Euxesta wettsteini* Hendel: a, wing; b, male genitalia.

Chrysomyza Fallén, 1817, Scenop. et Conops. Svec.:3 (unjustified new name for *Physiphora* Fallén). Type-species, *splendida* Fallén, by monotypy, = *demandata* (Fabricius).

Clio chloria Enderlein, 1927, Stettin. Ent. Ztg. 88:103. Type-species, *Musca aenea* Fabricius, by original designation.

The above synonymy is from Hennig (1940:10) who states that *Clio chloria* Enderlein may be a legitimate subgenus.

This genus is characterized by having a metallic blue or green body, hyaline wings, and cell R_5 closed and petiolate (in the Hawaiian species). Enderlein distinguished the subgenus *Clio chloria* by having a short petiole at the apex of cell R_5 (fig. 6d).

***Physiphora aenea* (Fabricius) (figs. 6a-d)**

Musca aenea Fabricius, 1794, Syst. Ent. 4:335. Type-locality: Asia.

References: Hendel, 1909:614; Hennig, 1941:117.

Widespread in the lowlands throughout the islands.

Immigrant. Widespread over Asia, North and South America, Mexico, and Australia.

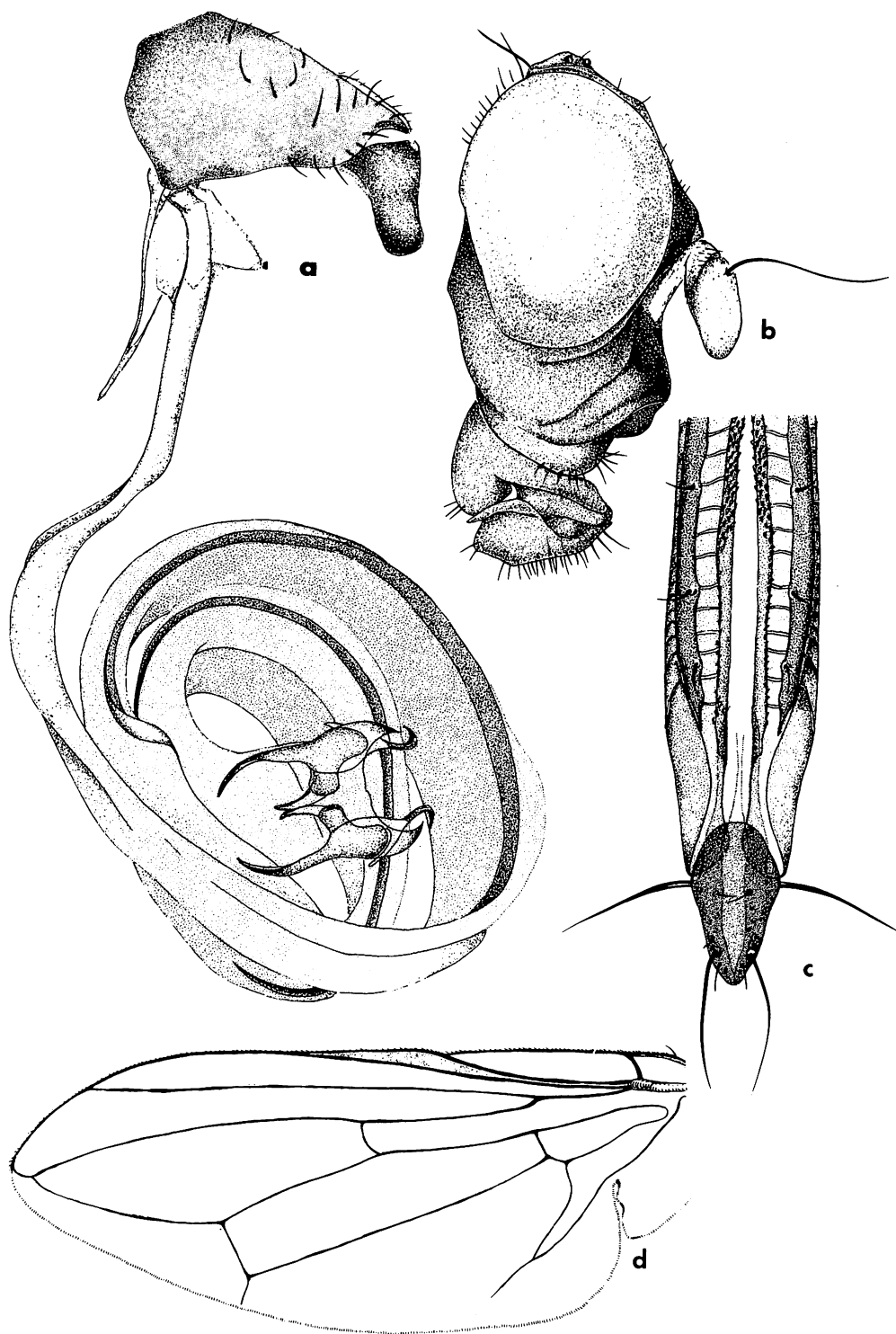


Figure 6—*Physiphora aenea* (Fabricius): a, male genitalia, lateral; b, head, lateral; c, female ovipositor; d, wing.

P. aenea was first recorded in Hawaii by Grimshaw (1902:85) from a single specimen taken "in the Honolulu Mts. in 1900." It has been reported breeding in cow and horse manure (Swezey, 1941a:12 and Fullaway, 1916:142) and in the filter press mud from the sugar cane factories (Swezey, 1925:48). Fullaway (*loc. cit.*) reported a high ("about 50%") rate of parasitism by *Spalangia*.

This distinctive species is readily differentiated from other Hawaiian Otitidae by its metallic blue-green color, hyaline wings, and distinctive venation. The profile of the head is as in figure 6b; the wing venation is as in figure 6d; and the male and female genitalia are as in figures 6a, c. The aedeagus is greatly enlarged, bare, and with specialized end structure. Surstyli simple, pointed. Three small round spermathecae present in female.

Length: body, 4.3–5.3 mm.; wings, 3.9–4.6 mm.

Swezey (1935:11) reported this species killed by balsa flowers (*Ochroma lagopus*).

Genus **PSEUDEUXESTA** Hendel

Pseudeuxesta Hendel, 1910, Gen. Insect. 106:11, 30. Type-species, *Euxesta prima* Osten Sacken, by original designation.

The members of this genus are differentiated from other Ulidiinae in the Pacific region by having vein R_1 bare; the third costal section (between apices of veins R_1 and $R_2 + 3$) very short, about one-fourth as long as the second section (fig. 7a); and by having the occiput rather broadly visible for the full length, as seen in lateral view (fig. 7b).

Pseudeuxesta prima (Osten Sacken) (figs. 7a–c)

Euxesta prima Osten Sacken, 1881, Ann. Mus. Civ. Stor. nat. Genova 16:470. Type-locality: Celebes. Type in the Museo Civico di Storia Naturale di Genova.

Euxesta semifasciata Malloch, 1930, Insects Samoa 6(5):216. Type-locality: Samoa.

Kauai, known in Hawaii only from a single specimen collected on Kauai in 1932 (Bryan, 1934:429). Specimens on hand are from Palmyra Island, May, 1959 (H. Caspers) and Yap Island.

Immigrant. Widespread through the Pacific region. For more specific records refer to Steyskal (1952:287).

This species more nearly resembles *Euxesta annonae* (Fabr.) and *wettsteini* Hendel than any other Hawaiian species; but the wing markings, venation (fig. 7a), shape of head (fig. 7b), and other details are very different.

Moderate-sized species with the body entirely shining black in ground color, with a metallic blue-green sheen and rather thickly covered with gray pollen. Mesonotum with two faint, slightly shining, vittae extending down median portion. Only one pair of dorsocentral bristles present; these are arranged in line with the prescutellar acrostichal bristles. The front is reddish brown me-

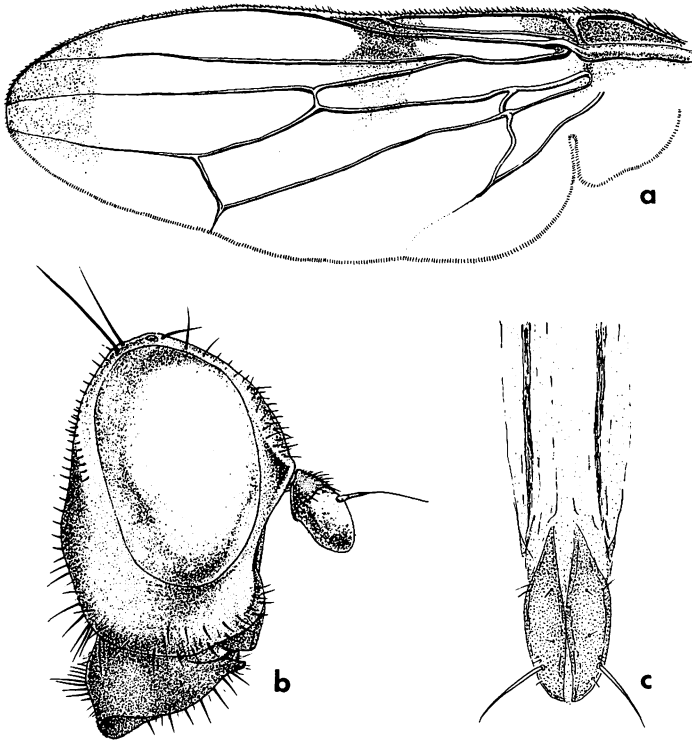


Figure 7—*Pseudeuxesta prima* (Osten Sacken): a, wing; b, head, lateral; c, female ovipositor.

dianly, silvery gray along orbits. Profile shape of the head is as in figure 7b. Legs black, except for yellow on mid and hind basitarsi and a tinge of rufous at apices of femora. Wings hyaline, except for a brown spot at apex, one in middle extending from costa from cell R_1 to vein $R_4 + 5$, and one in first costal cell (fig. 7a). Third costal section scarcely one-fourth as long as second. Only female specimens have been seen to date. The ovipositor long and slender, but the basal segment rather short; the base is about one-half longer than wide, about equal in length to terga four plus five, 1.2 mm. measured on the venter, and with a moderate concavity on posteroventral margin. Piercer 2.3 mm. long, rounded at apex, each side with one long, plus two short preapical setae and one small seta farther back on head portion (fig. 7c). Extended ovipositor 5.7 mm. Two small, round spermathecae.

Length: body, 5.0 mm., excluding ovipositor; wing, 4.75 mm.

Malloch's description (1930:216-217) is adequate.

Family PLATYSTOMATIDAE

The members of this family are differentiated from the Otitidae by having veins R_1 and $R_4 + 5$ haired above; the cubital cell not pointed; the arista

plumose; the costa broken near the humeral crossvein; in the Hawaiian species, lacking ocellar and postocellar bristles; and having the wings spotted with brown (fig. 8a). For the relationships with other families of Tephritoidea refer to Steyskal (1961b).

This family was not included in the key to families of Hawaiian Diptera (Hardy, 1960). It would run to couplet 28 (p. 33) and is differentiated from Otitidae as follows:

Veins R_1 and $R_4 + 5$ haired above. Cubital cell not pointed. Arista plumose. Ocellar and postocellar bristles lacking. **Platystomatidae.**
 Vein $R_4 + 5$ always bare, R_1 usually so. Cubital cell pointed. Arista bare or pubescent. Ocellar and postocellar bristles present. **Otitidae.**

Only one species of this family occurs in Hawaii, *Scholastes bimaculatus* Hendel. This has been previously treated in our literature under Otitidae.

Genus **SCHOLASTES** Loew

Scholastes Loew, 1873, Smithson. misc. Collns. 11:38. Type-species, *Platystoma cincta* Guérin-Meneville, by original designation.

In Malloch's key to the genera of "Platystominae" from Australia and New Guinea (1939a:99), this genus keys near *Celetor* Loew, but is differentiated by having cell R_5 not narrowed at apex; vein $R_2 + 3$ extending nearer to costa than to $R_4 + 5$; and the head, as seen in frontal view, broad, as wide as or wider than high.

Robust species, with one strong pair each of superior fronto-orbital and sternopleural bristles; scutellum subtriangular, densely short setose, with six marginal bristles and almost always with a broad yellow line extending down each side of mesonotum, continuous around margin of scutellum.

The larvae breed in rotting vegetable matter.

Scholastes bimaculatus Hendel (figs. 8a-e)

The Coconut Fly

Scholastes bimaculatus Hendel, 1914, Abh. zool.-bot. Ges. Wien. 8:253. Type-locality: Fiji.

Found in the lowlands on all of the main islands.

Immigrant. Fiji, Samoa, Society Islands, Ellice Islands, New Britain, and the New Hebrides.

This was first recorded in Hawaii by Swezey (1915:70) as *Paragorgopsis* sp? from specimens reared from maggots found in coconuts. The first adult specimen was collected by Terry in Honolulu in 1904. Also refer to Swezey, 1917:272.

According to Malloch's key (1939a:128) this species fits near *S. taylori* Malloch, from New Guinea, but differs by having only two pairs of dorsocen-

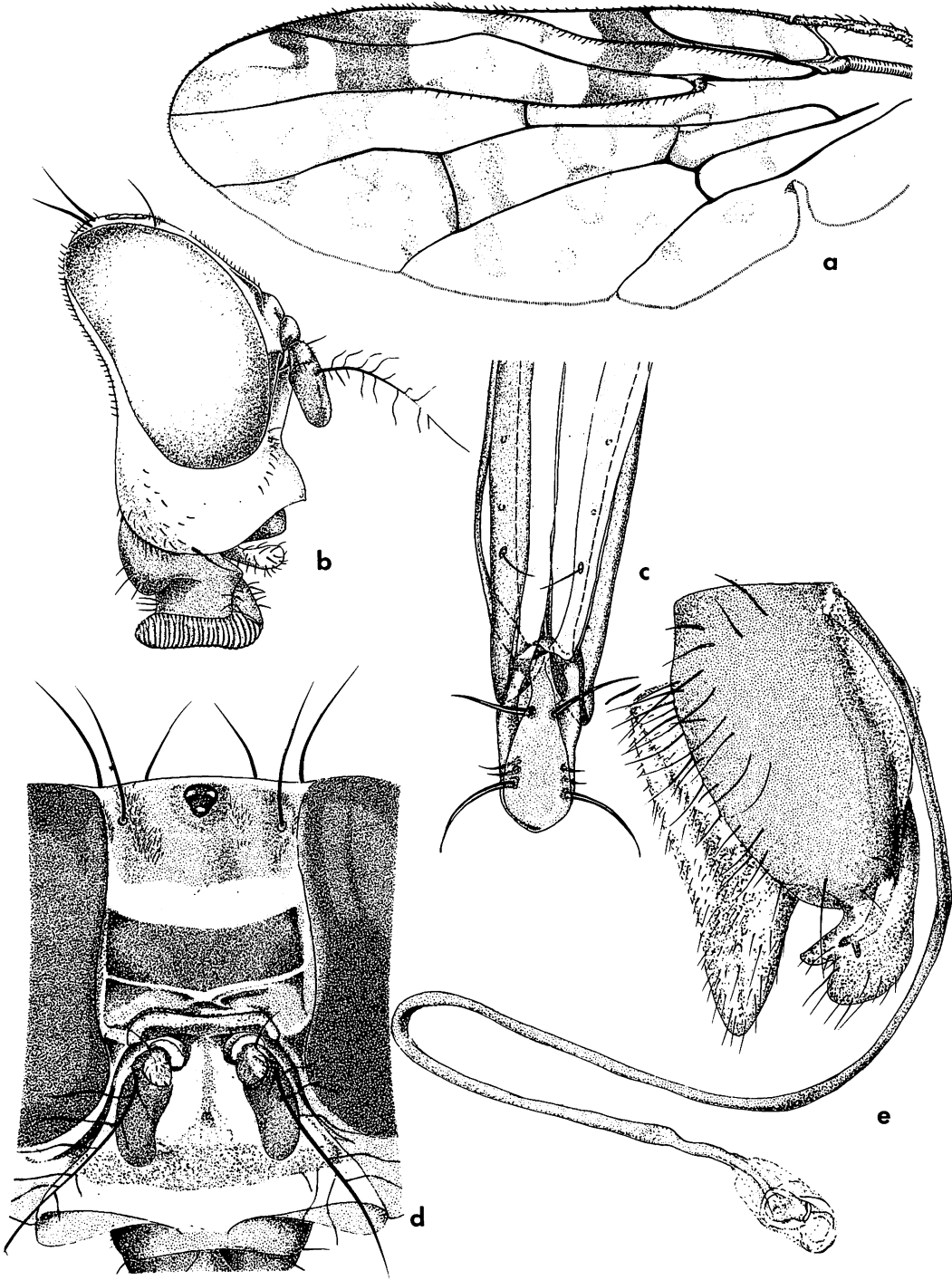


Figure 8—*Scholastes bimaculatus* Hendel: a, wing; b, head, lateral; c, female ovipositor; d, head, front view; e, male genitalia, lateral.

tral bristles; by being generally brown in color and with the pale vittae on mesonotum rather indistinct; and by having the wings speckled with pale brown and with two darker, prominent, subquadrate marks along costal margin, one just beyond the apex of subcostal vein and one before apex of vein $R_2 + 3$ (fig. 8a).

The markings on the front and face and the arrangement of the head bristles are as in figure 8d. The shape of the head in profile is as in figure 8b. The margin of the scutellum, the sides of the mesonotum, the upper portions of meso- and pteropleura, and the humeri (except for a brown spot above each bristle) are pale yellow. The notopleural callus and the depressed area of mesonotum above each wing base are brown. Thorax otherwise pale brown to almost black, except for three yellow-brown vittae extending longitudinally down mesonotum. Legs predominantly yellow, basitarsi yellow-white. Wing venation and markings are as in figure 8a. Male genitalia are as in figure 8e. Surstyli are simple; aedeagus long and slender, enlarged at apex. Female genitalia are as in figure 8c. Piercer blunt, rounded at apex with two strong and one tiny preapical setae on each side. Three small, round spermathecae.

Length: body, 5.0–6.4 mm.; wings, 5.3–6.75 mm.

This species apparently breeds only in rotting coconuts. The young maggots are white and the mature maggots are blue in color (Wilder, 1924:365). A few brief biological notes are given by Swezey (1924:389–390). The larvae are saltatorial; the blue coloring in the mature larvae is in the haemolymph, not in the digestive tract or the fat bodies.

Family TEPHRITIDAE The Fruit Flies

Medium-sized flies, mostly with pictured wings and often highly ornate. They fit near Platystomatidae and Otitidae, but differ by having well-developed inferior fronto-orbital and pteropleural bristles and by having the subcostal vein bent sharply upward at about a right angle before apex, weakened or evanescent beyond the bend, and costa with a break at apex of subcosta.

With very few exceptions, the larvae are herbivorous and infest various plant tissues. The Dacinae and many of the Trypetinae attack fleshy fruits of all kinds and are among the most serious pests of fruits and many vegetables, especially in the tropics. The Tephritinae are predominantly seed feeders living in the flower heads of Compositae and some other plants. Some genera and species (also Oedaspinae) are stem miners and gall formers on various plants, and some are flower feeders.

Thirty-six species are now known from Hawaii, of which 26 are endemic and 11 are immigrant, 6 having been purposely introduced for biological control of weeds and 5 accidentally introduced. Three of the species are serious

There has been considerable confusion in the literature concerning the family name of the fruit flies. In much of the literature they have been known as Trypetidae; Trupaneidae and Euribiidae also have been used. In accordance with Article 23(d)(i) of the International Code of Zoological Nomenclature, the correct name is Tephritidae and this name has been used consistently in the American literature since its status was clarified by Stone (1942:298, 299).

1. Chaetotaxy reduced; lacking dorsocentral, presutural, sternopleural, ocellar, and humeral bristles. Tergal glands present on fifth tergum of both sexes and a row of stridulatory hairs on each side of third tergum of male. Subfamily Dacinae, Genus **Dacus**. 2

Chaetotaxy more complete, not lacking the above bristles. 3

2(1). Mesonotum with three yellow longitudinal vittae behind suture. Wings with a large brown apical spot and with a brown mark extending transversely over m crossvein (fig. 10a).

. **Dacus (Zeugodacus) cucurbitae** Coquillett.

Mesonotum lacking a median yellow vitta. Costal band not expanded at wing apex, and no brown mark on m crossvein (fig. 9a).

. **Dacus (Bactrocera) dorsalis** Hendel.

- 3(1). Scutellum greatly swollen and polished black. Mesonotum polished black on sides and with an opaque black median stripe and flattened yellow setae as in figure 11e. Wings as in figure 11a. Subfamily Oedaspinae, Genus **Procecidochares** Hendel 4
 Not as above; scutellum flat. 5
- 4(3). Preapical hyaline mark from wing margin through cell R_3 extending into upper portion of cell R_5 (fig. 11Aa). **alani** Steyskal.
 Preapical mark in R_3 not extending into R_5 (fig. 11a). **utilis** Stone.
- 5(3). Occipital setae thin, sharp pointed, and black. Outer vertical bristles black. Setae of mesonotum not squamiform. Sixth tergum of female short in Hawaiian species, only a fraction as long as fifth. Subfamily Trypetinae. 6
 With at least some yellow or white, distinctly flattened, rather scale-like setae in the occipital row. Outer vertical bristles yellow-white, flattened (fig. 22b). Setae of mesonotum usually yellow to white and flattened, scale-like. Sixth tergum of female equal or longer than fifth. Subfamily Tephritinae. . . . 7
- 6(5). Pleura and legs yellow. Mesonotum shining black with a silvery gray pattern as in figure 41d. Scutellum shining black except for a yellow border along base. Wing markings as in figure 41e. Lower pair of upper fronto-orbital bristles modified into large spatulate bristles in the male (fig. 41a). **Ceratitis capitata** (Wiedemann).
 Pleura and legs predominantly brown. Mesonotum subshining brown to black on sides, otherwise densely gray pollinose. Apical two-thirds of scutellum yellow, base black. Wings and head not as above. **Rhagoletis cingulatus** Loew.
 (Not established in Hawaii. Intercepted at Honolulu, July 1940 [Krauss, 1941:15].)
- 7(5). Predominantly shining black species. Wings dark brown with large hyaline wedges on anterior and posterior margins (fig. 12a). Vein $R_2 + 3$ wavy, much shorter than normal, fourth costal section (between apices of veins R_1 and $R_2 + 3$) shorter than fifth. Cubital cell only slightly pointed at

- apex below. Tribe Tephrellini.
 **Xanthaciura connexionis** Benjamin.
 Densely gray pollinose species. Not as above. Tribe
 Tephritini. 8
- 8(7). Vein $R_4 + 5$ with setae along upper side, extending
 almost entire length. 9
 Vein $R_4 + 5$ bare above, or with 1-2 setae at base. . . . 10
- 9(8). Front bare of hairs down median portion. Wings
 dark brown with hyaline wedges along costal
 margin and round hyaline spots in median por-
 tion (fig. 20a).
 **Tetreuaresta obscuriventris** (Loew).
 Front with numerous flat, yellow hairs down me-
 dian portion. Wings largely yellow-brown to
 black with many hyaline spots as in figure
 13a. **Acinia picturata** (Snow).
- 10(8). Wings very broad and predominantly brown,
 covered with small hyaline spots (fig. 16a). Face
 with a velvety black spot on each upper lateral
 margin and with a pair of black spots in middle
 (fig. 16c). Gall formers on *Lantana*.
 **Eutreta xanthochaeta** Aldrich.
 Wings and face not as above. 11
- 11(10). Four scutellar bristles. 12
 Only two scutellar bristles. 14
- 12(11). Small species, 2.5 mm.; wings almost entirely
 hyaline (fig. 15b); head longer than high, pro-
 boscis elongate, geniculate (fig. 15a).
 **Ensina sonchi** (Linnaeus).
 Larger species, 4-5 mm.; wings mostly brown with
 small hyaline spots (fig. 17a). Head as high as
 long, proboscis not elongate (fig. 17c). **Neote-
 phritis** Hendel. 13
- 13(12). Femora, mentum and upper superior fronto-
 orbitals black. Abdomen entirely black setose,
 scutellum and pleura predominantly so.
 **paludosae** n. sp.
 Femora, mentum and upper superior fronto-
 orbitals yellow. Middle portion of abdomen, scu-
 tellum and pleura yellow setose. . . . **nigripilosa** n. sp.
- 14(11). Head higher than long, epistoma not strongly pro-
 jecting; labella fleshy, mouthparts not elongate;

- ### Subfamily DACINAE

Genus **DACUS** FabriciusSubgenus **BACTROCERA** Macquart

For synonymy under this genus refer to Hardy (1955:436).

This is the largest subgenus of *Dacus* with about 175 known species from the Oriental (including Japan, Ryukyu, and Bonin Islands), Australasian, and Pacific regions. One accidentally introduced species occurs in Hawaii.

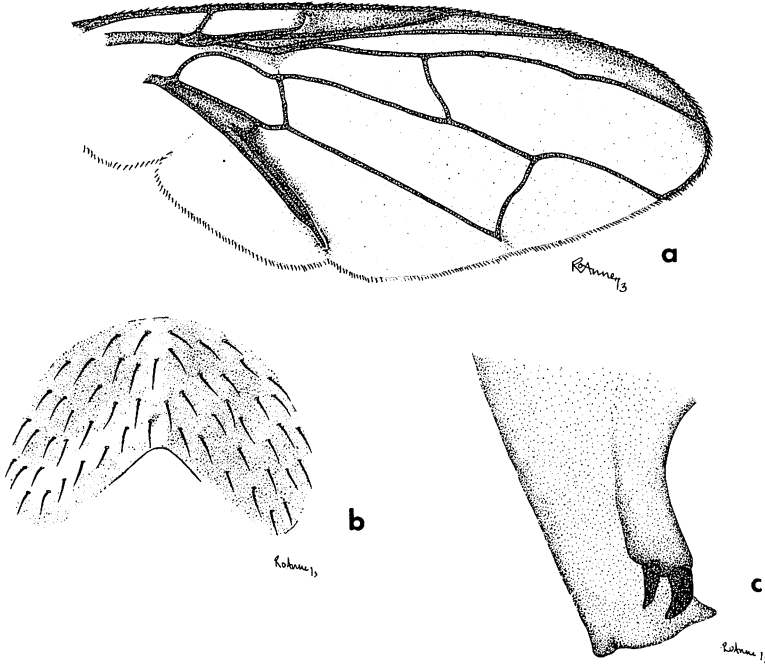


Figure 9—*Dacus (Bactrocera) dorsalis* Hendel: a, wing; b, fifth sternum of male; c, surstylus of male.

***Dacus (Bactrocera) dorsalis* Hendel (figs. 9a-c)**
The Oriental Fruit Fly

Dacus dorsalis Hendel, 1912, Suppl. Ent. 1:18. Type-locality: Koshuu, Formosa. For extensive synonymy and the confusion of names under this species refer to Hardy (1969).

Immigrant. Throughout the lowlands of all the Hawaiian Islands. Widespread over Oriental region, Micronesia, and Hawaiian Islands. Accidentally introduced into Hawaii 1944 or 1945; first recorded May, 1946 (Fullaway, 1947:8). It has been intercepted in California on several occasions but is not established there.

Hosts: Approximately 300 host fruits have been recorded. This species apparently will breed in all fleshy fruits. It is the most destructive fruit fly in the Oriental and Pacific regions and causes serious damage to commercial fruits throughout its range.

Parasites: In Hawaii this species is parasitized by *Opius longicaudatus* (Ashmead), *O. oophilus* Fullaway, and *O. persulcatus* (Silvestri). A microsporidian, *Nosema tephrititae* Fujii and Tamashiro is pathogenic to this species (ref. Fujii and Tamashiro, 1972).

D. dorsalis belongs in a complex of species characterized by having a pair of prominent black spots on the face; mesonotum predominantly black, or distinctly marked with black (in mature specimens) and with two postsutural

yellow vittae; scutellum yellow, except for a narrow band of black at base; wings hyaline, except for a narrow brown costal band and a longitudinal streak of brown through the cubital area and with the first two costal cells devoid of microtrichia except in apex of second; abdomen rufous, including the tergal glands on the fifth segment, with a black transverse band over base of third tergum and a black longitudinal vitta extending down middle of terga 3-5. It fits nearest to *pedestris* (Bezzi) from the Philippines and is differentiated by the shorter, less slender ovipositor of the female. The basal segment equals $\frac{1}{2}$ - $\frac{3}{4}$ as long as fifth segment of abdomen as seen from above and the extended ovipositor measures 4.5-4.7 mm. In *pedestris* the basal segment is longer than the fifth and the extended ovipositor is 6.0 mm. Wings as in figure 9a.

For more complete descriptive details refer to Hardy (1969) and also Shiraki (1968:23), under *Strumeta dorsalis okinawana* (Shiraki).

Subgenus **ZEUGODACUS** Hendel

Dacus (*Zeugodacus*) Hendel, 1927, Trypetidae 49. In Lindner, Die Fliegen der Pal. Reg. 5:26. Type-species, *caudatus* Fabricius, by original designation.

Following Drew (1972:8) this fits in the subgenera characterized by having hind margin of fifth sternum of male gently concave (fig. 10b) and the posterior lobe of surstylus elongate (fig. 10c). Otherwise these have the same characters as *Strumeta* except for typically having four scutellar bristles.

Drew has placed *Dacus cucurbitae* Coquillett in this subgenus. It is aberrant in that it typically has only one pair of scutellars; rudimentary secondary bristles are sometimes present.

***Dacus* (*Zeugodacus*) *cucurbitae* Coquillett (figs. 10a-c)**

Dacus cucurbitae Coquillett, 1899, Ent. News 10:129. Type-locality: Honolulu, Hawaii.

Immigrant. Throughout the Hawaiian Islands. Widespread throughout the Oriental region including China, Japan, Ryukyu Islands; much of the Pacific, including record from Darwin Northern Territories, Australia; Mauritius; East Africa, Kenya and Tanzania. Accidentally introduced into Hawaii from Asia about 1895. First recorded by Clarke (1898:6).

Hosts: This species has a wide host range: it attacks melons and cucurbits of all kinds, tomatoes and other solanaceous plants, string beans, peppers, egg-plants and other vegetables, and some fruits. It is one of the most serious pests of vegetable crops throughout its range.

For biological information refer to Back and Pemberton (1914, 1917, and 1918); for ecology and control refer to Nishida and Bess (1957); for characteristics of immature stages and comparative morphology of adults refer to Hardy (1949); and for pupal characters see Yamada, et al. (1963).

A predominantly yellow to rufous species with three postsutural yellow vittae on the mesonotum, no black markings except for a pair of spots on face, a

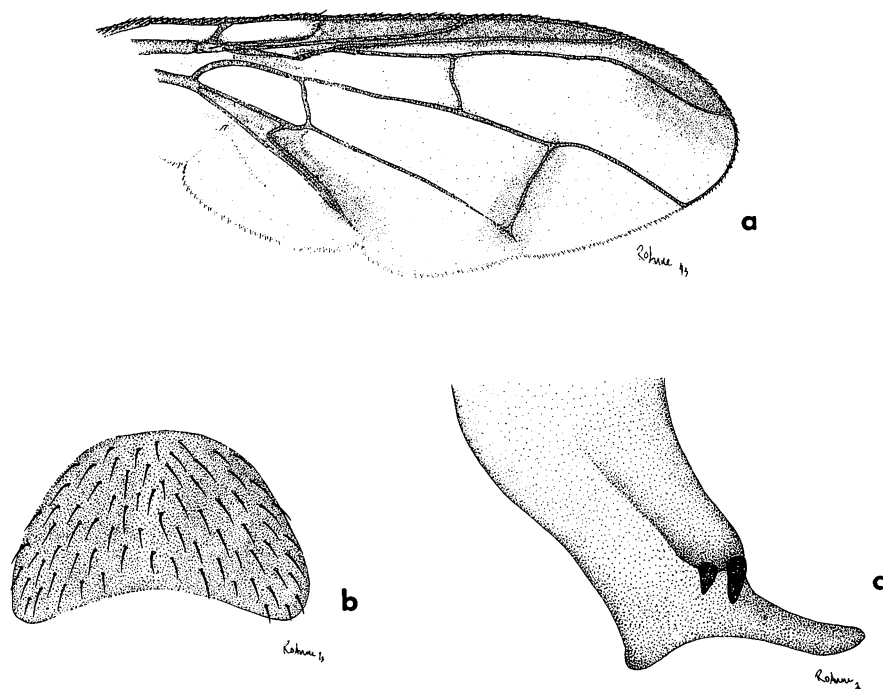


Figure 10—*Dacus (Zeugodacus) cucurbitae* Coquillett: a, wing; b, fifth sternum of male; c, surstylus of male.

narrow black basal band on third tergum, and a narrow black median vitta longitudinally down terga 3-5. It is differentiated from other *Dacus*, which have three postsutural yellow vittae and only two scutellar bristles, by the wing markings (fig. 10a) in combination with three pairs of inferior fronto-orbital bristles on front and a brown to black spot at base of each frontal bristle. The costal band is enlarged into a distinct spot at apex; a broad streak of brown extends along m crossvein and a faint marking of brown extends over r-m crossvein. The cubital streak (stridulatory structure which is made up of dense microscopic setae on ventral surface above cubital vein and which is used to rub over the rows of long hairs on the third abdominal tergum) of the male is well-developed.

Subfamily OEDASPINAE

Genus **PROCECIDOCHARES** Hendel

Procecidochares Hendel, 1914, Abh. Ber. K. Zool. Anth.-Ethn. Mus. Dresden 14(3):7, 42. Type-species, *Trypeta atra* Loew, by original designation.

Fitting near *Oedaspis* Loew, but differing by having the head higher than long with margins of face and front scarcely developed beyond eye margin as

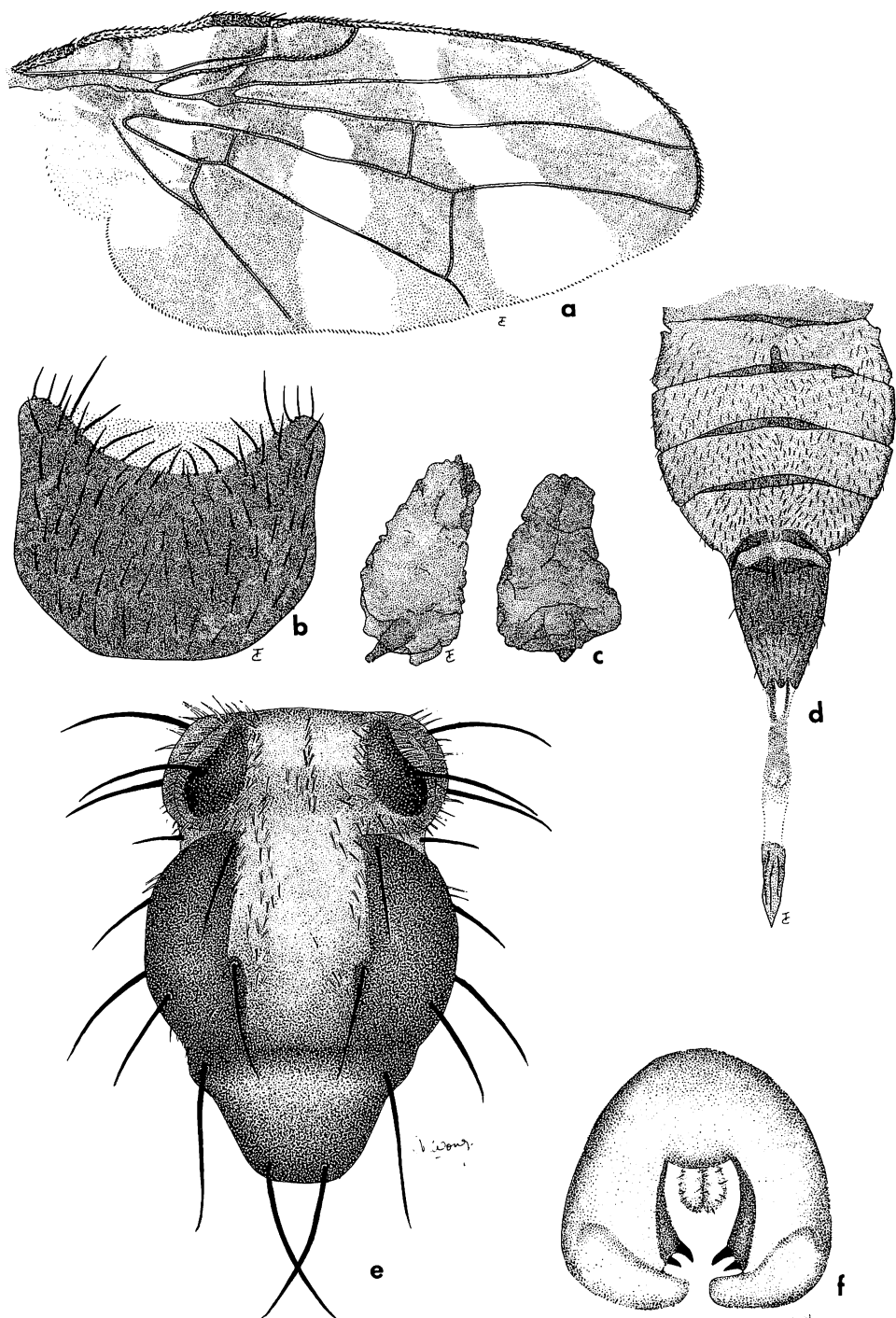


Figure 11—*Procecidochares utilis* Stone: a, wing; b, fifth sternum of male; c, female spermathecae; d, female abdomen; e, dorsum of thorax; f, male genitalia, end view.

seen in lateral view; the front not unusually broad and the body black, polished on mesonotum. Rather than having the head as long as high, the frontal and facial margins swollen, protruded well beyond eye; front broader than long; and body yellow.

This is the only representative of Oedaspinae in Hawaii and is easily separated by the greatly swollen, highly polished scutellum and by the wing markings (fig. 11a).

Fourteen species are known in the Neotropical and Nearctic regions; two have been purposely introduced into Hawaii.

***Procecidochares alani* Steyskal (figs. 11A a, b, e, f, i)**

Procecidochares alani Steyskal, 1974, Coop. Econ. Insect rpt. 24(32):639.

Type-locality: La Barranca del Tigre, Veracruz, Mexico.

Oahu, Hawaii.

Immigrant. Purposely introduced for biological control of *Ageratina riparia* (Regel).

Very similar to *P. utilis* Stone, but differing by having the preapical hyaline

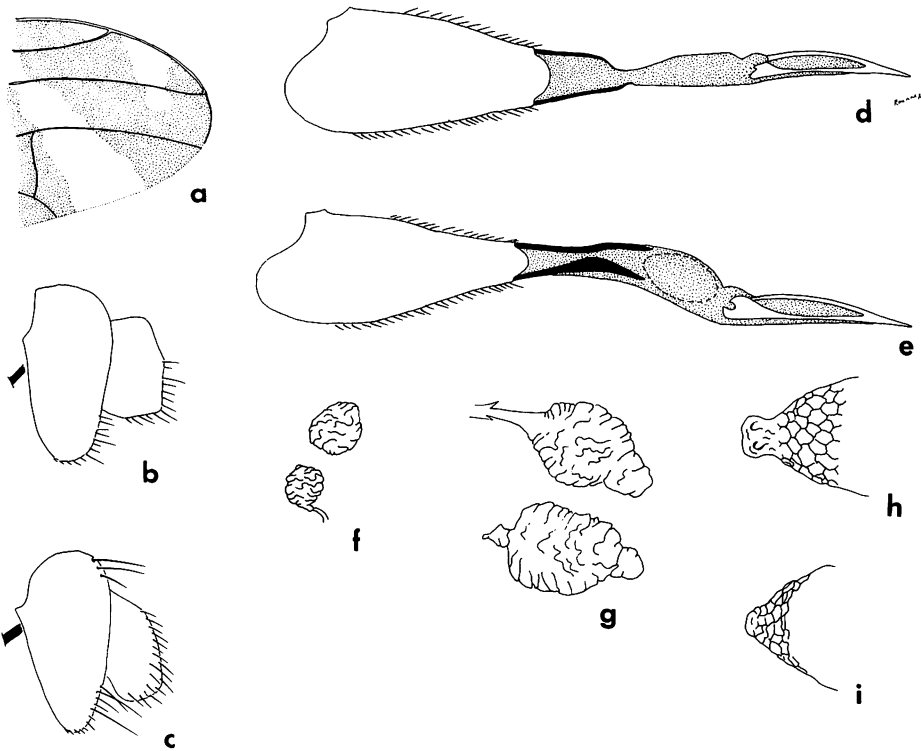


Figure 11A—*Procecidochares alani* Steyskal: a, apex of wing; b, male genitalia, lateral; e, female ovipositor, lateral; f, spermathecae; i, portion of egg. *P. utilis*: c, male genitalia, lateral; d, female ovipositor, lateral; g, spermathecae; h, portion of egg. (Copied from Steyskal, 1974:641.)

mark on the wing confined to cell R_3 , not extending into cell R_5 (fig. 11Aa), also, features of the postabdomen are distinctive in both sexes. In *alani* the epandrium of the male is more broadly rounded, as seen in profile, and the cerci rather quadrate in shape (fig. 11Ab), while in *utilis* the epandrium is tapered ventrally and the cerci more rounded (fig. 11Ac). The female ovipositors, in lateral view, differ as shown in figures 11Ad, e. The spermathecae differ considerably in the two: in *alani* they are much smaller, globular, about 0.050 mm. in diameter (fig. 11Af), while in *utilis* they are approximately three times larger and rather oblong in shape (fig. 11Ag). The eggs are also distinctive (figs. 11Ah, i): in *utilis* the micropilar end is distinctly knobbed and the reticulations of the chorion more expanded. For further diagnostic features refer to the original description.

***Procecidochares utilis* Stone (figs. 11a-f)**

Procecidochares utilis Stone, 1947, Proc. Haw. Ent. Soc. 13:97, fig. 1.

Type-locality: Cuernavaca, Morelos, Mexico.

Immigrant. Mexico, New Zealand. Widespread over Hawaiian Islands. Purposely introduced about 1946 from Mexico for biological control of *Eupatorium adenophorum* Spreng.

Hosts: Produces stem galls on *Eupatorium adenophorum* ("Maui Pamakani") and is instrumental in control of this weed. Ref. Bess and Haramoto (1958, 1959, 1972).

This species is differentiated from other *Procecidochares* by the pattern of the dorsal markings on the thorax (fig. 11e), the wing markings (fig. 11a), and the gray pollinose pleura.

Head higher than long, front sloping. Front yellow-orange, lunule, face and genae white. Three pairs inferior fronto-orbital and one pair superior fronto-orbital bristles. Thorax all black in ground color, polished on mesonotum and scutellum except for the broad gray median vitta on mesonotum; the latter area is covered with flat, yellow-white scales; these also extend along the suture and along hind margin of mesonotum. Legs yellow except for tinges of brown medianly on femora. Wing marking and venation as in figure 11a. Cell Cu with a short lobe at lower apex. Abdomen shining brown to black, tinged with rufous. Rather densely gray pollinose on first three terga and with abundant white, flattened setae. Sixth tergum of female equal in length to fifth. Fifth sternum of male wider than long, concave on hind margin. Genitalia of both sexes as in figures 11b, c, d, f.

Length: body and wings, 3.0-3.3 mm.

Subfamily TEPHRITINAE

Tribe TEPHRELLINI

Genus **XANTHACIURA** Hendel

Xanthaciura Hendel, 1914, Wien. Ent. Z. 33:86. Type-species, *Trypeta chrysura* Thomson, by original designation.

For synonymy under this genus refer to Benjamin (1934:43). We question the placement of *Tetraciura* Hendel as a synonym.

This genus is differentiated from other Tephrellini, which have only two scutellar bristles, by having vein $R_2 + 3$ strongly curved and much shorter than normal (fig. 12a), with the fourth costal cell shorter than fifth, and the cubital cell nearly truncate at apex. It fits nearest *Tephrella* Bezzi, but that genus has vein $R_2 + 3$ straight and elongate, with the fourth costal cell 3-4 times longer than fifth and cell Cu with a sharp point at apex. Head about as high as long with front sloping. Three pairs of inferior fronto-orbital and two pairs superior fronto-orbital bristles; the upper superiors rudimentary, small, yellow, scale-like. Dorsocentral bristles situated near suture.

The genus is Neotropical with extensions into the Nearctic region. Seventeen species have been described; one has been purposely introduced into Hawaii for weed control.

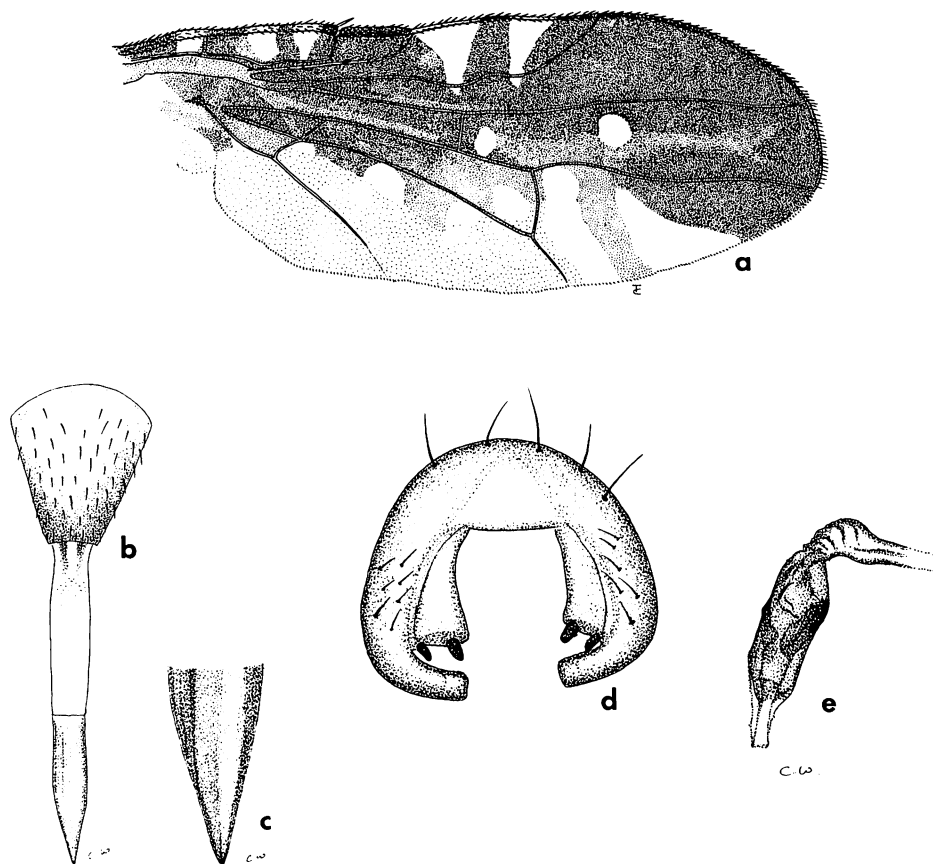


Figure 12—*Xanthaciura connexionis* Benjamin: a, wing; b, female ovipositor; c, apex of piercer; d, male genitalia, end view; e, apex of aedeagus.

Xanthaciura connexionis Benjamin (figs. 12a-e)

Xanthaciura connexionis Benjamin, 1934, U.S. Dep. Agric. Tech. Bull. 401:45. Type-locality: Florida, U.S.A.

Purposely introduced into Hawaii (Oahu) for biological control of *Eupatorium glandulosum* HBK and *riparium* Regel (Weber, 1956:162). Released on Maui and Oahu, May 1955. It is not known to be established.

Immigrant. Florida, Mexico.

Hosts: *Eupatorium* (*Conoclinium*) *coelestinum*, *E. glandulosum*, *E. riparium*, *Ageratum littorale*, and probably other Compositae.

A small species readily recognized by its wing markings and venation (fig. 12a). The thorax is polished black in ground color, with sterno and hypopleura yellow, rather thinly gray pollinose, not completely obscuring the shining ground color. The basal three terga of male are yellow, with the fourth marked with shining black medianly and fifth entirely polished black. In the female the fifth and sixth terga are shining black except for yellow lateral margins, fourth tergum with a black median spot, abdomen otherwise yellow except for a dark brown to black band across apex of basal segment of ovipositor. Wings as in figure 12a. Genitalia of both sexes as in figures 12b-e.

Length: body and wings, 2.0-2.5 mm.

Tribe TEPHRITINI

Genus **ACINIA** Robineau-Desvoidy

Acinia Robineau-Desvoidy, 1830, Essai sur les Myodaires:775. Type-species, *jaceae* Robineau-Desvoidy, by subsequent designation (Rondani, 1871:4), = *corniculata* (Zetterstedt).

This genus closely resembles *Xyphosia* Robineau-Desvoidy, by having vein $R_4 + 5$ setose above, three pairs inferior fronto-orbital and two pairs superior fronto-orbital bristles; and the wings dark colored, with numerous small white spots (fig. 13a). It differs by having the dorsocentral bristles located near the suture, the arista bare and the upper superior fronto-orbital bristles directed backward; rather than having dorsocentrals about in line with supraalars, arista short and upper superior fronto-orbitals typically directed inward.

Small yellow-gray pollinose species with a dense covering of flat, yellow-white setae over mesonotum and abdomen. All body bristles are yellow.

The genus is represented by two Palaearctic species, one Nearctic (and Hawaiian), and eight Neotropical species.

Acinia picturata (Snow) (figs. 13a-f)

Tephritis picturata Snow, 1894, Kans. Univ. Quart. 2:173. Type-locality: Florida, U.S.A.

Acinia fucata, authors (North American and Hawaiian references), not Fabricius. For discussion of synonymy refer to Foote (1964, Proc. Ent. Soc. Wash. 66(2):84).

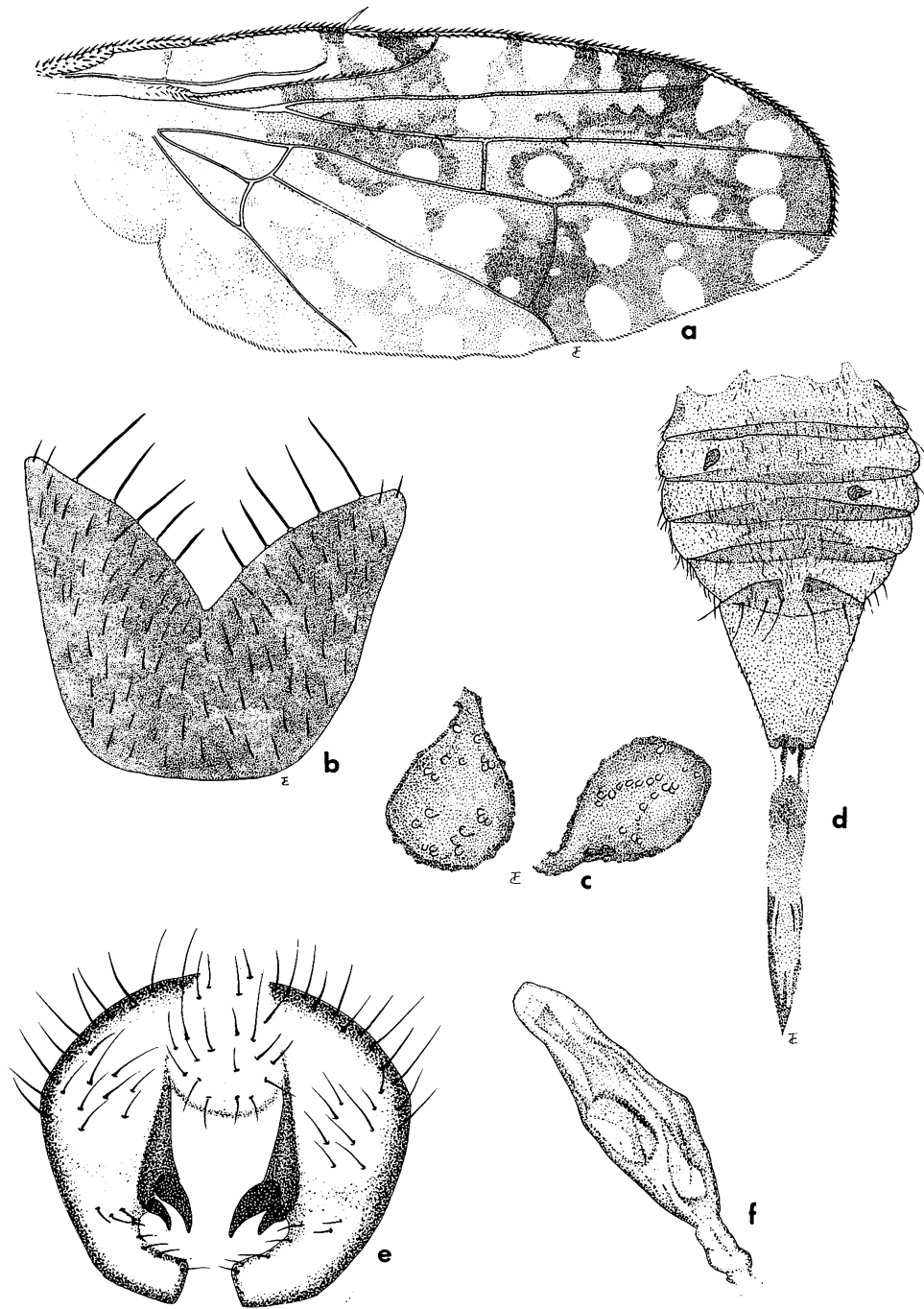


Figure 13—*Acinia picturata* (Snow): a, wing; b, fifth sternum of male; c, female spermathecae; d, female abdomen; e, male genitalia; f, apex of male aedeagus.

Immigrant. Widespread on all the main islands. Widely distributed over U.S., California to Florida, New York to Georgia; Mexico; West Indies; Hawaii; Wake and Johnston Islands.

Hosts: The larvae breed in flower heads of various species of *Pluchea*. Purposely introduced into Hawaii from Guatemala, Oct. 6, 1959 (Davis, 1961:315; also Davis and Krauss, 1962a:67) for control of *Pluchea odorata* (Linnaeus). Now well established on all the main Hawaiian Islands.

Fitting near *Tetreuaresta obscuriventris* (Loew) by having vein $R_4 + 5$ setose above over most its length; scutellum with four bristles; three pairs inferior fronto-orbital and two pairs superior fronto-orbital bristles; dorsocentral bristles situated near the suture; and the wings spotted. It is differentiated by having the front rather densely covered with flat, yellow scales, rather than bare of setae; the apical scutellar bristles subequal to the basal bristles, rather than about half as long; the mesonotum, scutellum, and abdomen densely covered with flat, scale-like, yellow-white setae, rather than having the disk of scutellum bare, and mesonotum and abdomen with the setae not so flattened or as abundant. The wings differ as in figures 13a, 20a. Fifth sternum of male as wide as long with a broad V-shaped concavity on hind margin (fig. 13b). The male genitalia are as in figures 13e, f, and the female ovipositor as in figure 13d. Two pear-shaped spermathecae present (fig. 13c).

Length: body and wings, 3.0–3.2 mm.

Genus **DIOXYNA** Frey

Dioxyna Frey, 1944, Comment. Biol. Soc. Fenn. 8(10):62. Type-species, *Trypeta sororcula* Wiedemann, by original designation.

This genus is differentiated from other Tephritini, which have only two scutellar bristles, by having the head elongate, distinctly longer than high, and by the absence of preapical setae on the male aedeagus.

Front with two pairs of inferior fronto-orbital and two pairs of superior fronto-orbital bristles; proboscis elongate and geniculate; anterior dorsocentral bristles about opposite supraalars; and wings (fig. 14b) spotted.

Six species have been placed here: one tropicopolitan; two North American; one South American; one (with two subspecies) from New Caledonia, New Guinea, and Indonesia; and one from the Philippines.

Dioxyna sororcula (Wiedemann) (figs. 14a–d)

Trypeta sororcula Wiedemann, 1830, Aussereurop. zweifl. Insekt. 2:509.

Type-locality: Teneriffe.

Dioxyna sororcula (Wiedemann) Frey, 1944, Comment. Biol. Soc. Fenn. 8:62.

Oahu, Molokai, probably widespread.

Immigrant. Widespread throughout the tropics and subtropics of the world. Accidentally introduced into Hawaii. First reported April-May, 1966 (Hardy,

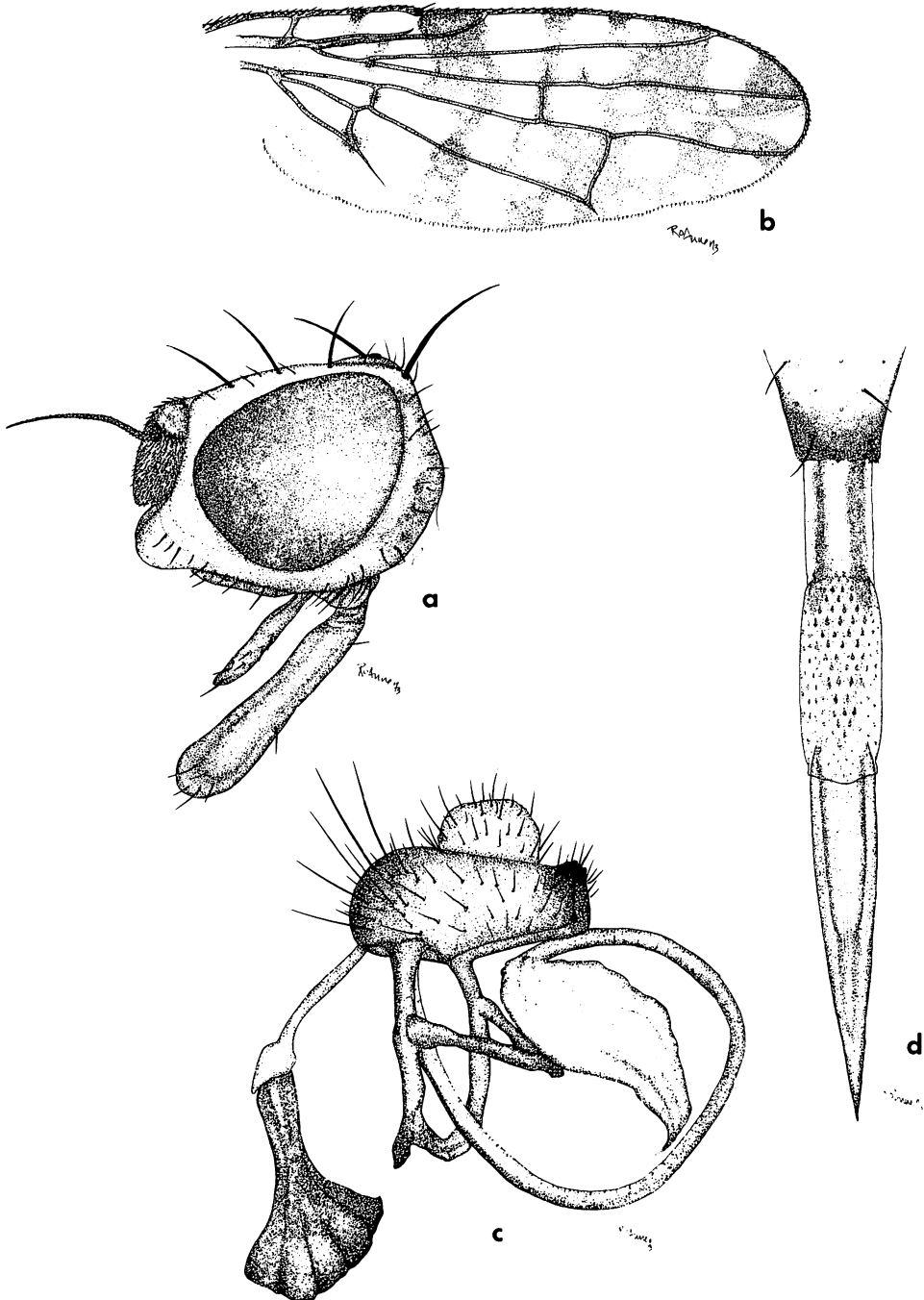


Figure 14—*Dioxya sororcula* (Wiedemann); a, head, lateral; b, wing; c, male genitalia; d, female ovipositor.

1967:333) as *Paroxyna sororcula*. Adults collected on pigeon peas (*Cajanus flavus* DC) on Oahu.

Hosts: A seed infester, living in flower heads of *Bidens*, *Coreopsis*, *Lactuca* and other Compositae. It has been reared from *Bidens pilosa* L. on Oahu and has been associated with native *Bidens* on Molokai.

A small species easily recognized by the elongate head, with the epistoma and sides of face protruded, and by the long geniculate proboscis (fig. 14a), in combination with the presence of only two scutellar bristles, dorsocentral bristles about in line with supraalars and wings diffuse brown with numerous hyaline spots (fig. 14b). Genitalia of both sexes as in figures 14c, d.

Length: body and wings, 2.5–3.0 mm.

Genus **ENSINA** Robineau-Desvoidy

Ensina Robineau-Desvoidy, 1830, Essai sur les Myodaires: 751. Type-species, *Musca sonci* Linnaeus, by subsequent designation of Hendel (1914:96).

This genus is readily differentiated by the almost completely hyaline wings, lacking brown markings except for a spot in the subcostal cell and faint indications of brown in cell R (fig. 15b). It is further characterized by the long, slender, geniculate proboscis; three pairs inferior fronto-orbital and only one pair of superior fronto-orbital bristles. The arista very short (fig. 15a); apical scutellars large, about equal in size to basal bristles; dorsocentral bristles situated nearer the supraalars than to the suture; and head narrowed anteriorly (fig. 15a).

This is a Palaearctic and Neotropical genus comprising about six Neotropical and European species, with one widespread throughout the entire Palaearctic region, Philippines, and Hawaii.

Ensina sonchi (Linnaeus) (figs. 15a–d)

Musca sonchi Linnaeus, 1767, Syst. Nat. Ed. 12:998. Type-locality: unknown (Europe?).

For synonymy under this species refer to Hendel (1927:171) and Shiraki (1968:82).

Oahu. Accidentally introduced into Hawaii, first recorded March 12, 1968, resting on *Sonchus oleraceus* at Ewa, Oahu (1968, FAO Plant Prot. Bul. 16(4):74; Au, 1969:270) and is presently known only from Oahu.

Immigrant. Widespread over Europe and Asia, it has been recorded from Manchuria, Taiwan, Okinawa, Japan, and the Philippines.

Hosts: Larvae breed in developing seeds of a wide variety of Compositae such as *Sonchus*, *Crepis*, *Tragopogon*, *Lactuca*, *Aster*, and *Cirsium*.

Parasites: A pteromalid wasp, *Hebrocytes* sp., recorded parasitizing this species (Drake, 1972).

The species has been adequately described and figured by Shiraki (1968:82 pl. 31) except for genital characters. It is differentiated from other Tephritini

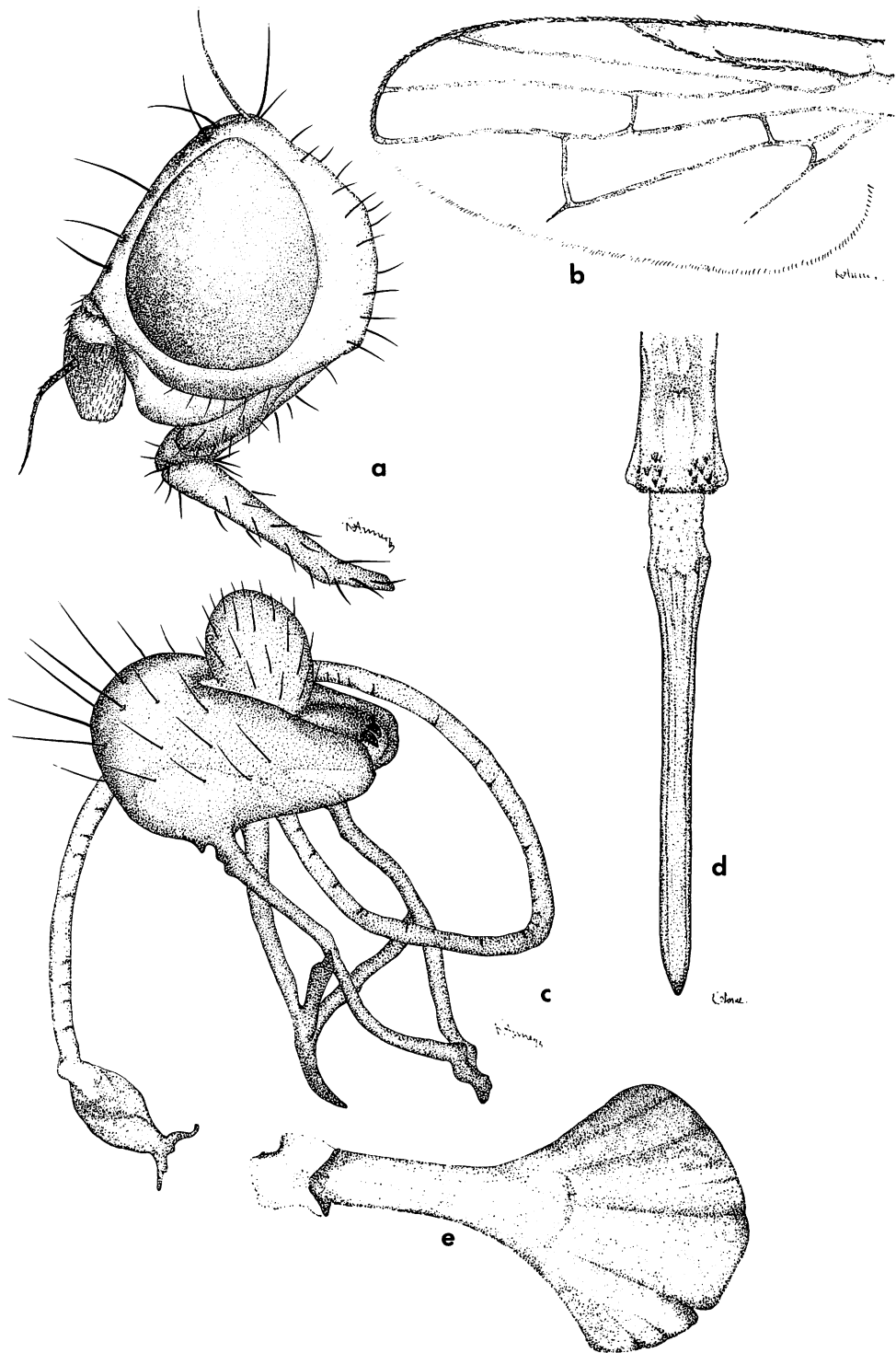


Figure 15—*Ensina sonchi* (Linnaeus): a, head, lateral; b, wing; c, male genitalia; d, female ovipositor; e, ejaculatory apodeme.

by the almost complete lack of wing markings (fig. 15b). Vein $R_4 + 5$ is bare. Vein $M_3 + 4$ evanesces before reaching wing margin and the cubital cell has only a slight point at lower apex. Head shaped as in figure 15a. Genitalia of both sexes as in figures 15c, d. Two rather elongate spermathecae present.

Length: body and wings, 3.0 mm.

Genus **EUTRETA** Loew

Icaria Schiner, 1868, Reise Fregatte Novara, Zool. 2(1):276 (preocc. by Saussure, 1853). Type-species, *Trypeta sparsa* Wiedemann, by original designation.

Eutreta Loew, 1873, Monogr. N. Amer. Dipt. 3:276. Type-species, *Trypeta sparsa* Wiedemann, by designation of Coquillett (1910:543).

This genus is readily recognized from other Tephritini by the broad, dark colored wings with an abundance of small subhyaline spots over the field (fig. 16a). The head is narrowed anteriorly as seen in lateral view; the front is sloping, the face concave, and the epistomal margin protruded. Three pairs inferior fronto-orbital and two pairs superior fronto-orbital bristles present. Postocular row with about six rather widely-spaced, large, flat, white setae (bristles) and numerous short, flattened, black setae. Dorsocentrals situated slightly nearer suture than to supraalars. Middle of front with numerous yellow-white scales and dorsum of thorax densely scaled. Sixth tergum of female about equal to fifth.

A Neotropical-Nearctic genus of about 24 species. One has been purposely introduced into Hawaii for weed control.

Eutreta xanthochaeta Aldrich (figs. 16a-f)

Eutreta xanthochaeta Aldrich, 1923, Proc. Haw. Ent. Soc. 5:261. Type-locality: Honolulu, Hawaii.

For synonymy refer to Stone, et al. (1965:661).

Widespread over the Hawaiian Islands and an important agent in keeping *Lantana* in check. Purposely introduced into Hawaii from Mexico in 1902 (Perkins and Swezey, 1924:79) for control of *Lantana camara* L.

Immigrant. Mexico, Guatemala, Hawaii.

Hosts: *Lantana camara* L. The larvae cause galls to form on the stems of the host.

This conspicuous species is readily differentiated by the all yellow head and body bristles, and its large, almost all brown wings with abundant small subhyaline spots scattered over the field. The thorax and abdomen are predominantly reddish to yellow-brown, densely covered with flat, yellow-white, scale-like setae. Head yellow except for reddish brown eyes, a velvety black spot on each side of face opposite antennae, a round velvety black spot in each antennal furrow, and a tinge of brown on each gena below eye margin. Head, in lateral view, shaped as in figure 16c. Wings as in figure 16a. Vein

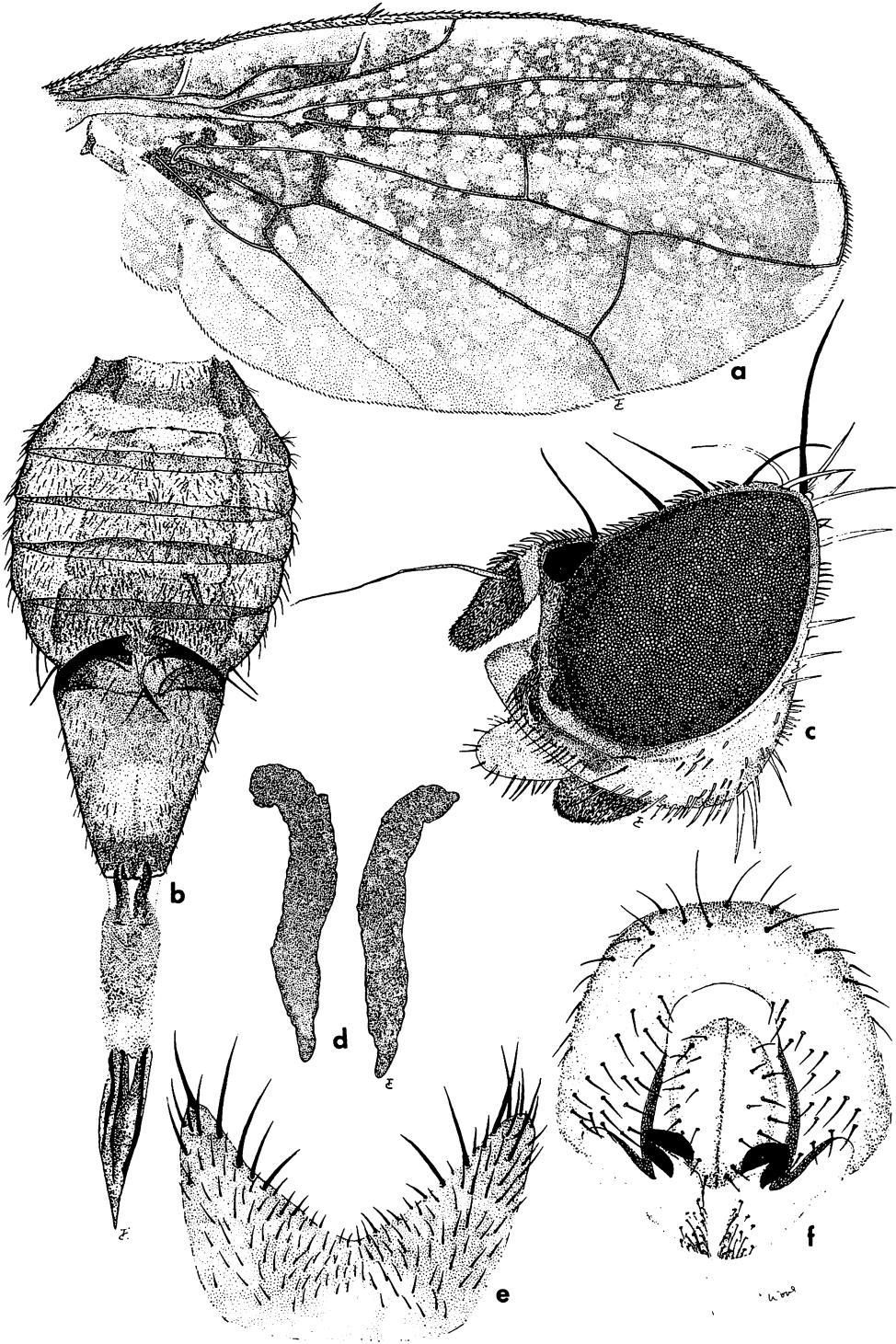


Figure 16—*Eutreta xanthochaeta* Aldrich: a, wing; b, female abdomen; c, head, lateral; d, spermathecae of female; e, fifth sternum of male; f, male genitalia.

$R_4 + 5$ bare above, except for one or two setae at base, and with scattered setae on ventral surface extending almost to r-m crossvein. Fifth sternum of male about as wide as long with a deep V-shaped concavity on hind margin extending half the length of sclerite (fig. 16e). Genitalia of both sexes as in figures 16b, f. Female ovipositor tapered to a slender point and with two long, tubular spermathecae (fig. 16d).

Length: body and wings, 5.4–5.7 mm.

This species has apparently been rarely seen outside Hawaii. When Aldrich described the species he had specimens only from Hawaii. He later reported to Dr. Illingworth that he had secured a specimen from Coban, Guatemala (Bryan, 1927:364). Mr. George Steyskal, U.S. Dept. Agriculture, recently mentioned (pers. comm.) that he was unable to find Aldrich's specimen from Guatemala in the National Museum collection, but had found "a rather moldy male" reared from "broad-leaf Verbenaceae" in Cuernavaca, Mexico, 1953.

Genus **NEOTEPHRITIS** Hendel

Neotephritis Hendel, 1935, Konowia 14:54. Type-species, *Trypeta finalis* Loew, by original designation.

Foote (1960b:145) gives the following generic diagnosis for *Neotephritis*: "Three pairs lower fronto-orbitals; two pairs upper fronto-orbitals, the posterior pair reclinate, not convergent; ocellars at least as long as posterior lower fronto-orbitals. No presutural dorsocentrals; one pair postsutural dorsocentrals, situated closer to transverse suture than to supraalars; two pairs scutellars. Wing pattern primarily a dark field with rounded hyaline or yellowish-hyaline spots, those immediately distad of stigma close together and forming an inverted triangular area extending from costa to vein R_5 ; vein R_5 bare at node and beyond."

Foote also discusses the relationship of *Neotephritis* to other genera of Tephritinae. *Neotephritis* is differentiated from *Trupanea* Schrank by having four scutellar bristles, rather than two, and it differs from *Tephritis* Latreille by having three pairs of lower fronto-orbital bristles, rather than two pairs.

This is a New World genus. According to Foote and Blanc (1963:35), nine species are known: one South American, five Mexican, and three North American. Two apparently new species from Maui fit here. Foote (1960b) has treated the North American species.

***Neotephritis nigripilosa* Hardy, new species** (figs. 17a–c)

This species is readily differentiated from other known Tephritinae from Hawaii, except for *paludosae* n. sp. which differs by the characters given under that species by having four scutellar bristles rather than two and by the characters given in couplet 13 of the above key. It differs from any of the known North American species of this genus by having a hyaline apical spot

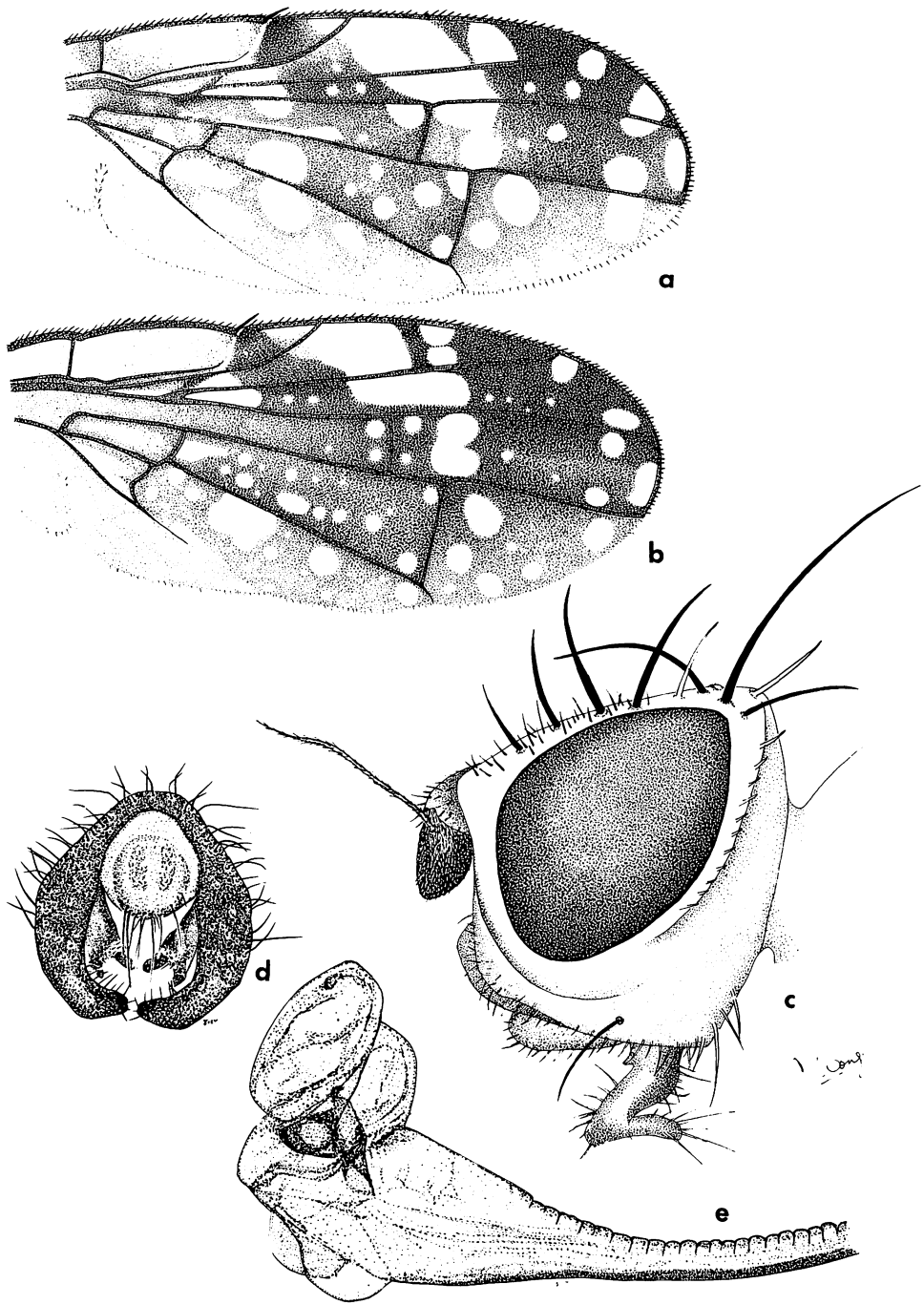


Figure 17—*Neotephritis nigripilosa* Hardy, n. sp.: a, wing of male; b, wing of female; c, head, lateral. *N. paludosae* Hardy, n. sp.: d, male genitalia, end view; e, apex of aedeagus.

on the wing; the other wing markings, body vestiture, and other details also differ. It seems to fit closest to *N. straminea* (van der Wulp), from Mexico, than any other species known to me. It differs, however, by having the pile of the dorsum of thorax and abdomen predominantly black, not yellow; by the scutellum and abdomen being all black, not tipped with rufous; by having only two hyaline spots on the costa in cell R_1 , not three; as well as by other details of the wing markings (figs. 17a, b). Compare with figure 23, plate 12 of van der Wulp (1900).

MALE. Head: Almost as long as high (fig. 17c) and predominantly yellow in color. The upper median portion of occiput brown to black in ground color, covered with gray pollen. Front rufous, eye orbits and lunule yellow in ground color covered with gray pollen. Face and genae rather densely gray pollinose. Palpi and mouthparts yellow. Each palpus rather thickly covered with black setae around apex. Face slightly concave, epistoma prominent. Occiput rather strongly swollen on lower portion; at broadest point, it is approximately two-thirds the length of one eye. Gena rather broad, almost one-third eye height; each eye is oval, approximately one-third higher than long. Three pairs of well-developed inferior fronto-orbital and two pairs upper superior fronto-orbital bristles present, the hind pair yellow-white but almost equal in length to first pair. Inner vertical bristles are strong, approximately equal in size to dorsocentral bristles on thorax. Antenna rufous, tinged with brown on second segment, arista brown, except for yellow base, and densely pubescent. **Thorax:** Black in ground color, rather densely yellow-gray pollinose, with three very faintly indicated narrow brown vittae extending down mesonotum. Mostly black setose on dorsum, with white scale-like setae only around margin of mesonotum. Scutellum yellow setose, except for a few brown setae on sides, and pleura yellow setose, except for a few brown setae on hind margins of mesopleura. Anterior dorsocentral bristles situated just behind suture. Both notopleural bristles black and well developed. One black bristle is developed near upper margin of each mesopleuron, pteropleuron, and sternopleuron; several black setae are also present in vicinity of these bristles. Halteres and humeri yellow. **Legs:** Entirely yellow except for a faint tinge of brown on the upper edge of each front femur. Posteroventral bristles of each front femur extend irregularly almost to base of segment; those bristles on basal half are smaller, more scattered. Several brown to black posterodorsal bristles are present on each mid and hind coxa. Front tibia with several rows of short, black, erect setae extending down dorsal surface; these also extend over first two or three tarsomeres. Front basitarsus approximately one-third as long as tibia and with two rather prominent erect anteroventral hairs. **Wings:** Predominantly brown, covered with hyaline spots. Second costal cell and basal cells of wing rather faintly infuscated with brown. Subcostal cell dark brown with a hyaline spot at apex. The wedge-shaped marking extending through wing from costal margin just beyond the apex of vein R_1 is not so distinctly triangular in shape as in most species of *Neotephritis*. The hyaline marking is broken into two large spots in cell R_1 ; as one broad, hyaline mark, this extends diagonally through

cells R_3 and R_4 ending at vein $M_1 + 2$ just above the m crossvein. A prominent apical spot is present at the tip of cell R_5 ; the other markings of wing are as in figure 17a. Calypters pale on margins, the fringe yellow. *Abdomen*: Shining black in ground color, rather thickly gray pollinose, and black setose on sides, yellow in middle of terga. The genitalia have not been dissected for study; *in situ* the cerci appear to be about two times longer than wide. The fifth sternum is distinctly wider than long.

Length: body, 3.9 mm.; wings, 4.0 mm.

FEMALE. Fitting the description of the male in most regards, but differing by having posterior notopleural bristles yellow; by slightly different markings of wing (fig. 17b); no evidence of vittae on mesonotum; as well as by sexual differences. The base of the ovipositor is polished black, covered with black setae, and approximately two times longer than wide and slightly longer than terga 5 + 6 as seen from above. Measured on the venter the basal segment is 1.7 mm. The piercer has not been extruded for study.

Length: body, 5.3 mm.; wings, 5.7 mm.

Holotype male and allotype female, Holua, Haleakala Crater, Maui, 6500 feet, June 1953 (D. E. Hardy).

Type and allotype in B. P. Bishop Museum.

***Neotephritis paludosae* Hardy, new species (figs. 17d-e)**

Resembling *nigripilosa* n. sp. and obviously closely related to it. It is differentiated by having the femora, mentum, and upper superior fronto-orbital bristles black; abdomen entirely black setose and scutellum and pleura predominantly so; calypters bordered with brown and fringed with black hair; costal cells blackish and mesonotum with distinctly brown vittae in both sexes. The wing markings are very similar in the two species and I see no consistent differences except that in *paludosae* the hyaline spots in cell 2nd M_2 are not so clearly defined.

MALE. Fitting description of *nigripilosa* in most respects, excepting those characteristics mentioned above. *Head*: Eyes red in live specimens. Fitting *nigripilosa* (fig. 17c) except for the black upper superior fronto-orbital bristles. *Thorax*: Mesonotum mostly gray pollinose, yellow-brown posteriorly, and with three distinct brown vittae extending from in front of postero-dorsocentrals to anterior margin. Scutellum gray pollinose in middle, yellow-brown on sides, rather thick black setose with a few scattered yellow setae on apicomedian portion. Mesonotum entirely black setose except for yellow hairs around margin. Pleura entirely black setose except for yellow setae on upper median portion of each mesopleuron. Posterior dorsocentrals distinctly closer together than anterior pair; the spacing between the bristles is approximately equal to that between the humerals and presuturals. *Wings*: As in *nigripilosa* (fig. 17a) except that the costal cells are tinged with black and the spots in 2nd M_2 are less distinct. Margins of calypters brown to black, fringed with black hairs. Halteres yellow. *Legs*: Coxae mostly black, tinged with rufous, trochanters

yellow, tinged with brown to black on hind pair; femora black, except for narrow yellow apices, and tibiae and tarsi yellow. Front basitarsus short—about one-third as long as tibia—and with two moderately long ventral setae near basal third of tarsomere. *Abdomen*: Entirely black, covered with yellow-gray pollen and densely black setose except for some yellow setae on sides of basal segment. Genitalia as in figures 17d, e.

Length: body and wings, 6.0–6.25 mm.

FEMALE. Fitting description of male in most respects. Basal segment of ovipositor shining black, equal in length to terga 4 + 5. The piercer has not been extruded for study.

Length: body and wings, 6.5–6.7 mm.

Holotype male and allotype female, Upper Hana Forest, Maui, 5500 ft., July 7, 1973. Collected on greensword, *Argyroxiphium virescens* var. *paludosa* St. John (D. E. Hardy). Fifteen paratypes: eleven males and four females, same locality and host plant as type (D. E. Hardy, S. L. Montgomery, and C. W. Whittle)—some reared.

Type, allotype, and some paratypes in B. P. Bishop Museum. Remainder of paratypes in collections of U.S. National Museum, British Museum (Natural History) and the University of Hawaii.

It appears obvious that this species, as well as *nigripilosa* n. sp., is monophyletic with the species of large, densely spotted winged *Trupanea* such as *swezeyi* (Bryan), *denotata* n. sp., and others. Also, it seems evident that, at least in dealing with Hawaiian species, the presence of four vs. two scutellar bristles is of not more than species group importance. Based upon world classification, *paludosae* and *nigripilosa* seem to fit all of the characteristics of *Neotephritis*.

Genus PHAEOGRAMMA Grimshaw

Phaeogramma Grimshaw, 1901, Fauna Hawaiiensis 3:47. Type-species, *vittipennis* Grimshaw, by original designation.

This is a Tephritini near *Trupanea* Schrank and the two known species may possibly be aberrant *Trupanea*. It appears to be distinctive because of the unusual wing markings (figs. 18a, 19), with two hyaline crossbands before the apex and r-m crossvein situated very near m, about half its length from the m crossvein, and near apical 3–5 of 4th costal section (between apices of vein R_1 and $R_2 + 3$). The type species has two pairs of superior fronto-orbital bristles (Grimshaw reported only one) and three pairs of inferior fronto-orbitals. A new species on hand, from Maui, has 10 pairs of inferior fronto-orbital bristles. The mesonotum, scutellum, and dorsum of abdomen are densely covered with flattened, yellow-white setae.

Apparently these are stem miners, gall formers on native plants. Two species are recognized and it is possible that a third may occur on Kauai. Swezey (1954:36) found empty puparia in stems of *Bidens cosmoides* at Kokee.

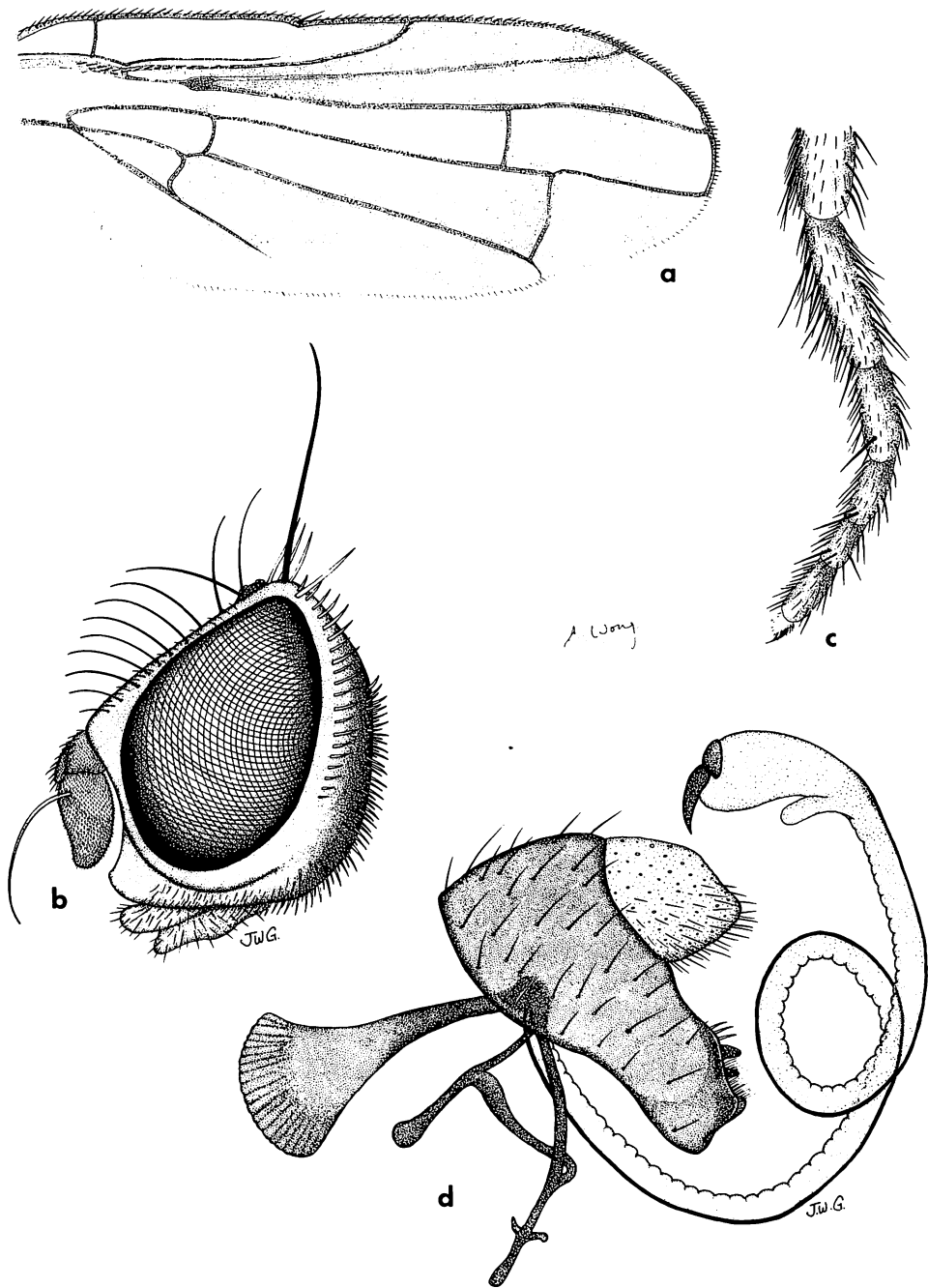


Figure 18—*Phaeogramma hispida* Hardy, n. sp.: a, wing; b, head, lateral; c, front tarsus of male; d, male genitalia, lateral.

***Phaeogramma hispida* Hardy, new species (figs. 18a-c)**

Fitting near *vittipennis* Grimshaw but differing by having 8-10 pairs of inferior fronto-orbital bristles, having the apices of cells R_5 and 2nd M_2 hyaline in male, brown in female, and having different markings as in figure 18a.

This is the specimen which was determined as *P. vittipennis* by Swezey (1954:36), reared from *Bidens* sp. on Maui.

MALE. Head: About as high as long with the epistomal margin protruding, the face gently concave in lateral view, the front sloping, and the antennae situated slightly above middle of head (fig. 18b). Head yellow except for compound eyes and black ocellar triangle. Eyes higher than long. Occiput only slightly swollen and genae rather narrow; the latter densely covered with short brownish-yellow setae. Front about as wide as long, measured from median ocellus to frontal suture. With eight to ten pairs of closely placed, brown, inferior fronto-orbital and two pairs superior fronto-orbital bristles; the lower pair are brown, the uppers are yellow, tinged with brown. Ocellar bristles dark brown to black; all other head bristles and setae yellow, those of occipital row flattened. The genal bristle lacking or not differentiated from the dense setae. Third antennal segment dark brown to black except for yellow base. Palpi and mouthparts yellow. Palpi with numerous brown setae ventrally and rather sparse yellow setose on sides and on dorsum. **Thorax:** Mostly polished black in ground color, covered with flat, yellow setae on the dorsum. Dense gray pollen obscures the ground color, except for a narrow polished brown band down each side of mesonotum and a median polished brown streak over scutellum. Humeri, notopleura, lateral margins of mesonotum, sides of scutellum, and the postscutellum yellow. Pleura mostly dark brown to black, yellow on upper mesopleuron and on propleuron. Metanotum black. All thoracic bristles black; dorsocentrals situated just behind suture. **Legs:** Entirely yellow, with yellow setae over dorsal surface of front femur and short, recumbent, brown setae over remainder of legs. Front femur with a row of five to six brownish-yellow, postero-ventral bristles on apical half of segment. Front basitarsus about one-fourth as long as tibia, nearly two times longer than second tarsomere and with moderately long, erect, yellow setae ventrally (fig. 18c). Middle tibia with one strong black apical spur and five or six short, black apical bristles. **Wings:** As in figure 18a, similar in most respects to *vittipennis*. **Abdomen:** First tergum yellow, remainder of terga shining brown to black in ground color, densely gray pollinose and thickly yellow setose except for a narrow area devoid of setae extending longitudinally the full length down the middle. The bristles at apices of the terga are yellow, except for yellow-brown bristles on sides of fifth. The genitalia are dark brown to black, fifth sternum slightly wider than long and with a broad concavity on posterior margin, extending two-fifths the length of the sclerite, and with two black setae on each side of hind margin. Anal lobes conspicuous, equal in length to epandrium. Surstyli broad and blunt at apices, and apical processes of 10th sternum thick

and blunt. Details of the aedeagus, ejaculatory apodeme, and other structures as in figure 18d.

Length: body, 5.5 mm.; wings, 5.0 mm.

FEMALE. Fitting description of male except for having apex of wing brown as in *vittipennis*; also the upper superior fronto-orbital bristles are yellow. This may be a variable character; in females of the Oahu population some specimens have these bristles yellow and some have them brown. Base of ovipositor equal in length to terga five and six and almost entirely covered with flattened yellow setae.

Length: body, excluding ovipositor, 5.8 mm.; wings, 5.4 mm.

Holotype male, allotype female and 15 paratypes, 14 males, one female from Puu Lanilili, Makakaole, West Maui, 2300 ft., Oct. 12, 1975, and March 8, 1978, reared ex galls on *Bidens* (D. E. Hardy and S. L. Montgomery). Also one male paratype Iao Valley, West Maui, reared from gall on native *Bidens* July 29, 1906, no collector given.

Type, allotype, and some paratypes in B. P. Bishop Museum. Other paratypes in collections of the U. S. National Museum, British Museum (Natural History), and the University of Hawaii.

A series of four females and five males from Palikea Trail, Waianae Mts., Oahu, 2400 ft., January 7, 1978, reared from galls on *Bidens* (S. L. Montgomery) appear to be this, but are not being included in the type series.

***Phaeogramma vittipennis* Grimshaw (fig. 19)**

Phaeogramma vittipennis Grimshaw, 1901, Fauna Hawaiiensis 3:48, pl. II, figs. 26-27. Type-locality: Molokai Mts., 2000 ft.

Endemic. Molokai. Known only from the type series, 2 males, 1 female, collected by Perkins, September 1893.

Type male and allotype female in British Museum (Nat. Hist.). The location of the male paratype is unknown.

Similar to *hispidula* n. sp. but with only three pairs inferior fronto-orbital bristles, not ten. The wings are very similar except that *vittipennis* has the apex entirely brown and the hyaline crossband beyond m crossvein is two times broader than the brown transverse band over r-m and m crossveins (fig. 19).

The following notes are based upon the type male and allotype female in the British Museum (Natural History). Both are in good condition. Head about as high as long, rather square in profile (fig. 19). Front produced slightly at the antennae and face nearly straight, just slightly concave in lateral view. Genae one-fourth to one-third the eye height at their broadest point. Front and face entirely yellow, grayish white pollinose along sides. Antennae yellow. Front with three pairs of black, inferior fronto-orbitals and two pairs of superior fronto-orbitals. The occiput has a row of flat, yellow bristles extending along sides. Palpi yellow with a clump of short, black bristles at apices. Thorax chiefly black in ground color, humeri and sides of scutellum yellow. Pleura with

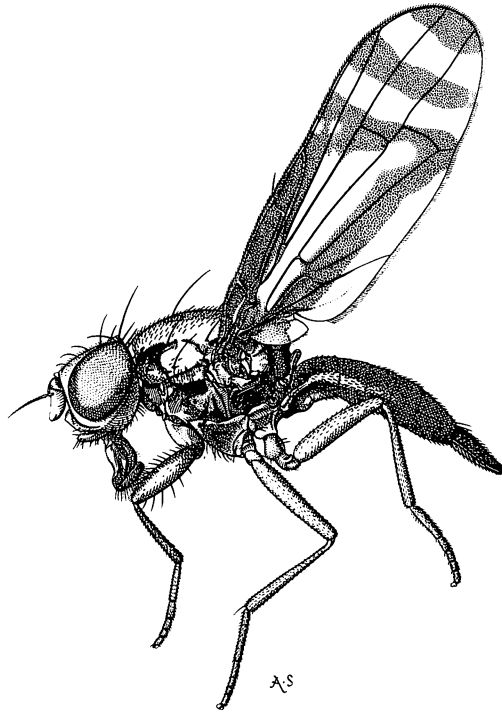


Figure 19—*Phaeogramma vittipennis* Grimshaw: whole drawing of type female.

rather extensive markings of yellow. The thoracic bristles are black except for notopleurals which are yellow-red. The dorsocentral bristles are situated almost in line with the suture. Mesonotum and scutellum densely pollinose; the former is chiefly gray, with a broad yellow-brown pollinose stripe extending from hind margin to dorsocentral bristles, becoming very narrow at this point and extending as a thin line to front margin. Scutellum chiefly yellow-brown and legs yellow to rufous. Wings as in figure 19; the dark brown markings form a very characteristic pattern. Abdomen subshining black, thinly grayish brown pollinose, densely covered with flat, yellow-white hairs. All abdominal bristles yellow-white except for a single pair of black bristles at apex of fifth tergum (it is possible that there should be four or more black bristles at the apex of the fifth; some are obviously broken off). Basal segment of female ovipositor, *in situ*, is slightly longer than the last two abdominal segments.

Length: body and wings, 3.0–3.5 mm.

Genus **TETREUARESTA** Hendel

Tetreuaresta Hendel, 1928, Ent. Mitt. 17:368. Type-species, *Euaresta obscuriventris* Loew, by original designation.

Tetraeuaresta, error or emendation.

Fitting the main characteristics of *Acinia* Robineau-Desvoidy, as noted under the description of *A. picturata* (Snow), but differing by having the front rather strongly narrowed below and devoid of setae or scales, except for a few setae along eye margins; the scutellum bare, except for scattered setae on margin; and wings dark brown with comparatively large hyaline marks on margin and few spots in field (fig. 20a).

This is a Neotropical genus. Nineteen species have been placed here; all are confined to tropical America except for *T. obscuriventris* (Loew), which has been purposely introduced into Fiji and Hawaii for biological control of a weed.

Tetreuaresta obscuriventris (Loew) (figs. 20a-f)

Euaresta obscuriventris Loew, 1873, Monogr. N. Amer. Dipt. 3:313, pl. 10, fig. 26. Type-locality: Brazil.

Kauai, Oahu, Maui and probably on other main Islands. Purposely introduced from Fiji to Hawaii Dec. 1, 1961 (Chong, 1962:25) for control of *Elephantopus mollis* (HBK). It was released on Kauai and is now well established on that island. It has been released on Hawaii but not yet recovered. It has been collected on Oahu and Maui (top of Haleakala, 10,000 ft.).

Immigrant. Widespread over Neotropical Region, Fiji.

Host: *Elephantopus mollis* (HBK). Important for control of this noxious weed of rangelands.

Rather small, mostly black in ground color, densely gray pollinose, and yellow setose over mesonotum and basal two abdominal terga; remainder of abdomen black setose. Differentiated from other Hawaiian tephritids by the characters given under the generic discussion. All head and body bristles yellow. Scutellum, humeri, and legs yellow; sides of mesonotum, notopleural calli, and first two abdominal terga yellow to rufous. Wings marked as in figure 20a, base hyaline and otherwise largely brown. Vein $R_4 + 5$ with prominent setae above and below extending to beyond level with m crossvein. The fifth sternum of male shaped as in figure 20b and the genitalia of both sexes as in figures 20c, e, f. Two small, rounded, rather mushroom-shaped spermathecae present (fig. 20d).

Genus **TRUPANEA** Schrank

Trupanea Guettard, 1762, Mém. Acad. R. Sci. Hist. 1756:170-173. Unavailable name, author not binomial.

Trupanea Schrank, F. von P., 1795, Naturh. Ökon. Briefe Donaumoor:147.

Type-species, *radiata* Schrank, by monotypy, = *stellata* (Fuessley).

Trypanea, emendation.

Urellia Robineau-Desvoidy, 1830, Essai sur les Myodaires (2)2:774. Type-species, *calcitrapae* Robineau-Desvoidy, by subsequent designation (Coquillett, 1910:818), = *stellata* (Fuessley).

Tephritis, subg. *Trypanoidea* Bryan, 1924, Proc. Haw. Ent. Soc. 5:367. **New synonym.** Type-species, *Trypeta crassipes* Thomson, by original designation.

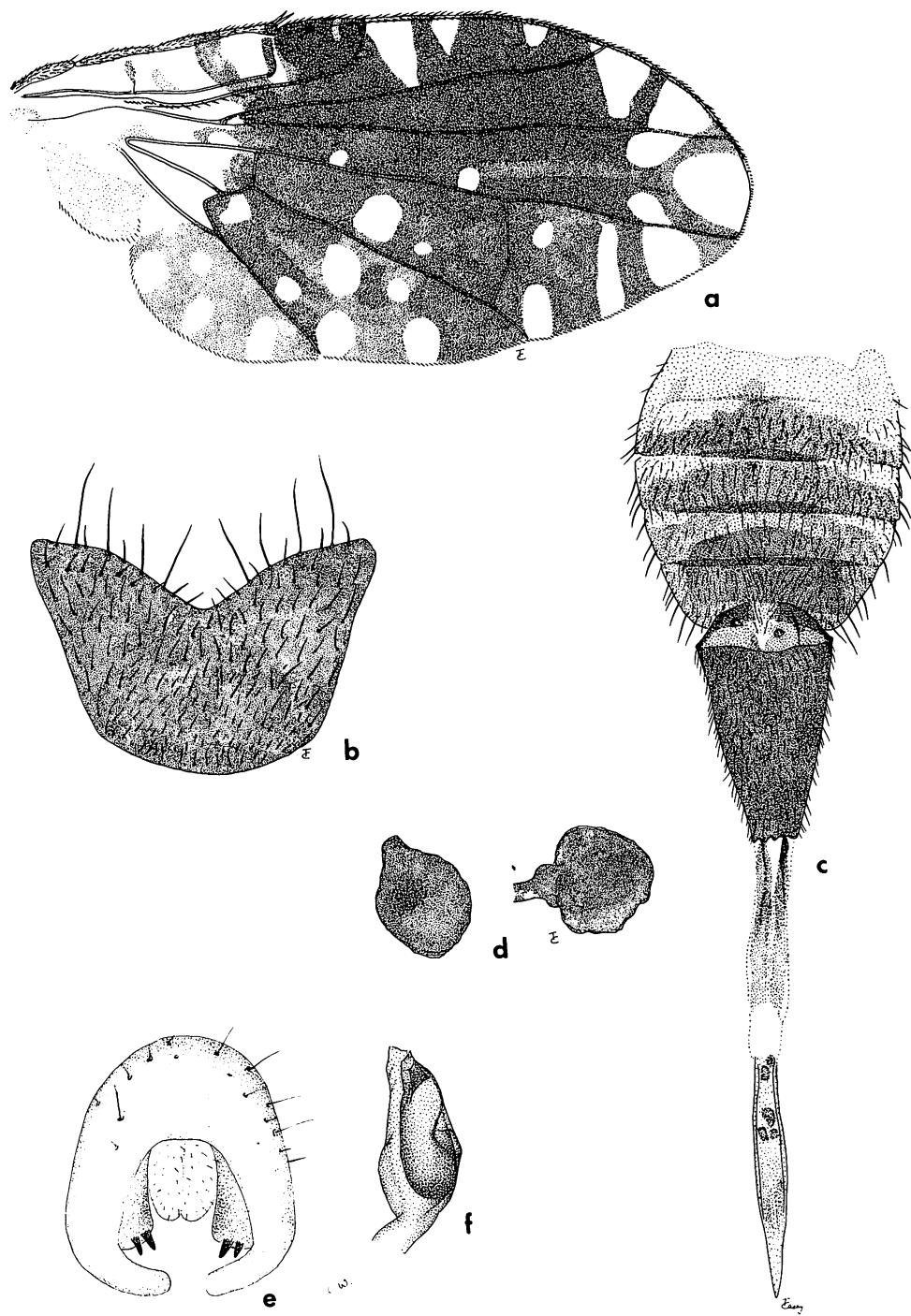


Figure 20—*Tetreuaresta obscuriventris* (Loew): a, wing; b, fifth sternum of male; c, female ovipositor; d, female spermathecae; e, male genitalia; f, apex of aedeagus.

This is a very large genus, world-wide in distribution. The species breed mostly in flower heads of various plants, especially Compositae. It fits in the complex of genera which have only two scutellar bristles; the proboscis short, labella fleshy; head approximately as high as long; and dorsocentral bristles situated near suture. It is differentiated by having two pairs of superior fronto-orbital and three to four pairs of inferior fronto-orbital bristles; aedeagus of male terminating in a sclerotized spine, and cubital cell pointed at lower apex. In typical *Trupanea* the wings are characterized by having a large, brown, preapical mark with brown rays extending to the margin (stellate pattern), and basal two-thirds hyaline, except for a brown mark often present in cell Sc. The Hawaiian species are aberrant in this regard and because of the arrangement of spots over the wings more closely resemble *Tephritis* Latreille than they do *Trupanea* of other world areas. Our species have been confused under *Tephritis* in most of the Hawaiian literature. Based upon correspondence from Dr. M. Bezzi, Bryan (1924a:367) stated that the wing markings of Hawaiian species known to him were intermediate between *Tephritis* and *Trupanea* ("Trypanea"): "very like *Trypanea* in having a star-shaped terminal spot, which is, however, combined with a net-like pattern continued to the base of the wing." Bryan proposed the new subgenus *Trypanoidea* for *T. crassipes* (Thomson), *cratericola* (Grimshaw), and *dubautiae* (Bryan). *Tephritis* are differentiated from *Trupanea* by having four scutellar bristles and only two pairs of inferior fronto-orbitals.

The Hawaiian species exhibit a remarkable range of variation in pattern of wing markings (figs. 24a, 25a, 37a) and these do not appear to be of any value as generic or subgeneric characters. In light of the knowledge we now have of the evolution and genetics of the Hawaiian *Drosophila*, it is obvious that wing maculations are important only as species group characters.

The females have two elongate spermathecae; these are weakly sclerotized, often difficult to discern in cleared specimens.

Five species of *Trupanea* have previously been described from Hawaii; 21 species are being treated here, 16 are new species.

For a thorough biosystematic study of the genus (in Africa) refer to Munro (1964).

KEY TO KNOWN SPECIES OF TRUPANEA SCHRANK

1. Wings almost entirely dark brown with no hyaline spots except for a few on margin (figs. 25a, 36c) and with no spots in field except for four tiny scattered white spots in *marginalis* n. sp. (fig. 34a). 2
- Wings variously spotted. (figs. 28c, 37a). 4
- 2(1). Cell R_1 entirely brown and no white spots in field of wing (figs. 25a, 34a, 36b). 3
- Cell R_1 with a large, elongate, white spot over basal one-third beyond vein R_1 and with a round spot in middle; one tiny white spot in cell R_5 just

- beyond r-m crossvein; one in middle of basal portion of R_5 ; one at apex and one at base of cell 1st M_2 (fig. 34a). Hawaii. **marginalis** n. sp.
- 3(2). Legs yellow. Thorax and abdomen yellow setose. Wings light brown with indistinct hyaline spots in lower half of cell M_4 and with cell R_3 all brown. Front basitarsus one-fourth as long as tibia and shorter than second tarsomere, bearing numerous long ventral hairs (fig. 25c). Hawaii. **celaeoptera** n. sp.
- Femora brown to black. Wings predominantly dark brown with lower one-half to two-thirds of cell M_4 hyaline and cell R_3 with one to two hyaline spots at apex (fig. 36b). Front basitarsus one-third tibia, two times longer than second tarsomere and with few short ventral setae (fig. 36c). Hawaii. **nigripennis** n. sp.
- 4(1). Abdomen as well as mesonotum completely covered with flattened, rather scale-like, yellow-white hairs. 5
- Abdomen predominantly black pilose. The mesonotum may be pale or predominantly black pilose. 16
- 5(4). Wings mostly brown, evenly covered with hyaline spots. No preapical or apical dark brown mark present (figs. 28c, 37a). By comparison the wings are more densely spotted. 6
- Each wing with a large dark brown preapical or anteroapical spot extending basad to level with m crossvein and which usually has radiating fuscous bands (figs. 21a, 30c). By comparison the wings are more sparsely spotted, with fewer but larger hyaline spots in cells. 9
- 6(5). Apices of cells R_5 and 2nd M_2 entirely hyaline. No black spot present on costa at apex of vein R_1 (figs. 28c, 32a). 7
- Apices of veins $R_4 + 5$ and $M_1 + 2$ marked with brown. Wing markings as in figure 37a. Costal vein with a brown mark opposite end of vein R_1 . Basal segment of female ovipositor equal in length to abdominal segments four to six. Cerci of male three to four times longer than wide. Hawaii. **pantosticta** n. sp.

- 7(6). Second costal section with two prominent brown marks extending over most of cell. Posterior portion of wing, cells M_4 and Cu, with brown markings extending to margin (fig. 38a) at least in female (see *limpidapex*). Front basitarsus of male equal in length to second tarsomere and with numerous long, ventral hairs. Tarsomeres two to four each with a long, curved, anterior cilia at or near apex (fig. 32b). 8
- Second costal section mostly hyaline, with only two small brown marks on margin; posterior portion of wing hyaline, brown marking not extending to margin (fig. 28c). Front basitarsus about two times longer than second and with few long ventral hairs and tarsomeres lacking long anterior cilia. Hawaii. **dempta** n. sp.
- 8(7). Subcostal cell almost entirely hyaline. Cells 1st M_2 , R_1 , and R_5 with numerous small white spots, approximately twenty in each cell (fig. 32a). Basal segment of female ovipositor elongate, as long as abdominal segments three to six. Maui.
- **limpidapex** (Grimshaw).
- Subcostal cell almost entirely brown. By comparison cells 1st M_2 , R_1 and R_5 are sparsely spotted, with about five to eight spots in each (fig. 38a). Ovipositor base not longer than four to six. Molokai. **pekloi** n. sp.
- 9(5). A large brown spot covers anteroapical portion of wing. Only a tiny hyaline spot in apex of cell R_5 and the markings over the wing are diffuse, rather faint (fig. 21a). Cercus of male bearing a long yellow bristle. Hawaii. **apicalis** n. sp.
- Not as above, with a preapical brown spot in wings, cell R_5 all, or mostly all hyaline and the pattern very different (fig. 30c). A strong bristle on cercus only in *dubautiae* (Bryan). 10
- 10(9). Front basitarsus of male less than one-third as long as tibia (figs. 30d, 35b), usually possessing long ventral hairs. Apices of cells R_5 and 2nd M_2 largely or entirely hyaline in both sexes, except in *dubautiae*, which is a small species (2.0–2.5 mm.) with a distinctive wing pattern (fig. 30c). 13
- Front basitarsus of male approximately one-half as long as tibia and lacking long hairs (fig. 26c).

- Apices of R_5 and 2nd M_2 marked with brown. Subcostal cell with a small apical hyaline mark (fig. 26a), or two hyaline marks as in figure 24a, or nearly all hyaline (fig. 22f). Basal half or two-fifths of seventh segment of female covered with yellow-white scales. 11
- 11(10). Wings with a continuous band of brown extending from the brown marking in cell Sc across middle of wing to margin in lower apex of cell M_4 . Cell Sc with a small apical hyaline mark (fig. 26a) or with two hyaline spots (fig. 24) 12
- Basal portions of cells R_3 , R_5 , 1st M_2 , and M_4 with a pattern of narrow, brown, alternating, transverse bands; these are discontinuous, not joined into a band over middle of wing. Cell Sc almost all filled with a hyaline spot (fig. 22f). Maui . . **artemisiae** n. sp.
- 12(10). Basal two-thirds of cell Sc brown to black, apex hyaline. Basal half of wing with large irregular hyaline areas (fig. 26a). Posteromedian portion of mesonotum yellow-brown pollinose and anterior half with three brown vittae. Oahu, Molokai, Maui, Hawaii, Lanai. Common on *Bidens*.
- **crassipes** (Thomson).
- Cell Sc with two hyaline marks. Basal half of wing covered with round hyaline marks (fig. 24a). Mesonotum entirely gray pollinose. Kauai, on native *Bidens*. **bidensicola** n. sp.
- 13(10). Cells R_5 and 2nd M_2 entirely hyaline at apices, wing markings as in figures 33a, 35a. Front basitarsus of male as long or longer than 2nd tarsomere. 14
- Apices of veins $R_4 + 5$ and $M_1 + 2$ broadly marked with brown in both sexes isolating a round hyaline spot at apex of cell R_5 . Wing markings as in figure 30c. Front basitarsus of male very short and broad, about half as long as 2nd tarsomere. A small species which infests flower heads of *Dubautia*. Oahu, Kauai. **dubautiae** (Bryan).
- 14(13). Front basitarsus of male approximately two times longer than second tarsomere and lacking elongate ventral hairs. Front tarsus also lacking prominent anterodorsal bristles at apices of segments. Subcostal cell with a large hyaline spot in middle.

- Two hyaline spots in cell R_1 , other wing markings as in figures 33a, 39a. Upper superior fronto-orbital bristles yellow-white. 15
- Front basitarsus of male about equal in length to second tarsomere and bearing elongate ventral hairs (fig. 35b). Front tarsus with a prominent black anterodorsal bristle at apex of each of tarsomeres one to four. Subcostal cell predominantly or entirely brown. Cell R_1 with a single large hyaline spot, other details of wing markings as in figure 35a. Upper superior fronto-orbital bristles usually black. Hawaii. **megaspila** n. sp.
- 15(14). Basal half of wing hyaline, sparsely streaked with brown, lacking round hyaline spots. Hind margin of wing, behind apex of vein $M_3 + 4$, hyaline (fig. 33a). Infests flower heads of *Lipochaeta*. Oahu. **lipochaetae** n. sp.
- Basal half of wing largely brown with round hyaline spots; the brown markings extend to wing margin in cell M_4 (fig. 39a). Kauai. **perkinsi** n. sp.
- 16(4). Mesonotum black setose, except for some thin white hairs around margin, not scaled. 17
- Mesonotum covered with yellow-white scales or flattened setae. 19
- 17(16). Femora, third antennal segment and apices of palpi brown to black. Wings predominantly hyaline marked as in figures 23a, 27d. Female ovipositor base elongate, about equal to abdominal segments two to six. 18
- Femora and palpi yellow to rufous. Antennae black only in *denotata* n. sp. Wings dark brown covered with small hyaline spots (fig. 29b). Female ovipositor base about equal to segments four to six. . . . 20
- 18(17). Cell 2nd M_2 , in both sexes, with three hyaline marks extending across cell to margin. Wings as in figures 27a, 27d. Fifth sternum of male one-half wider than long (fig. 27g). Upper superior fronto-orbital bristles usually yellow-white and a prominent white spot usually present at apex of subcostal cell. Maui. **cratericola** (Grimshaw).
- Cell 2nd M_2 brown along wing margin (figs. 23a, 23b). Fifth sternum of male slightly longer than

wide (fig. 23f). Upper superior fronto-orbitals of male black and cell Sc all brown. Maui.
. **beardsleyi** n. sp.

19(16). Legs yellow, tinged lightly with brown on femora. Front basitarsus of male one-third as long as tibia and with rather short ventral setae (fig. 40c). Wings dark brown, covered with small hyaline spots as in figure 40a. Second costal cell marked with brown. Cell R₅ with a small hyaline spot at apex. Arista bare except at base. Infesting flower heads of *Dubautia*. Oahu, Maui, and Kauai.
. **swezeyi** (Bryan).

Femora dark brown to black. Front basitarsus of male about one-fifth as long as tibia and with long ventral hairs. Second costal cell entirely hyaline. Apices of cells R₅ and 2nd M₂ hyaline in male (fig. 22a), and with large hyaline spots in apices of those cells in female. Arista microscopically pubescent. Hawaii. **arboreae** n. sp.

20(17). Antennae black. Wings mostly brown, lacking hyaline spots in second costal cell and no large spots filling apices of cells R₅ and 2nd M₂. Mesonotum with brown to dull black vittae on anterior half. Front basitarsus nearly two times longer than second tarsomere and with short ventral hairs. Maui. **denotata** n. sp.

Antennae yellow. Wings with two hyaline spots in second costal section and apices of R₅ and 2nd M₂ hyaline. Mesonotum all gray, lacking vittae. Front basitarsus much shorter than second tarsomere and with long ventral hairs (fig. 31b). Oahu, Molokai, Maui. **joycei** n. sp.

Trupanea apicalis Hardy, **new species** (figs. 21a-b)

Showing close relationship to *dubautiae* (Bryan), but differing from this, as well as from other known *Trupanea*, by having the entire anteroapical portion of wing dark brown (fig. 21a); also, the brown markings over the wing are diffuse, rather faint.

MALE. A small species fitting the characteristics of *dubautiae* in most respects. *Legs*: The front basitarsus is very short, about one-third as long as second tarsomere and with a dense clump of ventral setae; second tarsomere flattened laterally, somewhat contorted and with a row of short, black setae along ventral margin (fig. 21b). Legs mostly black setose, each front femur with two rows of prominent erect setae extending down dorsal surface; these are black

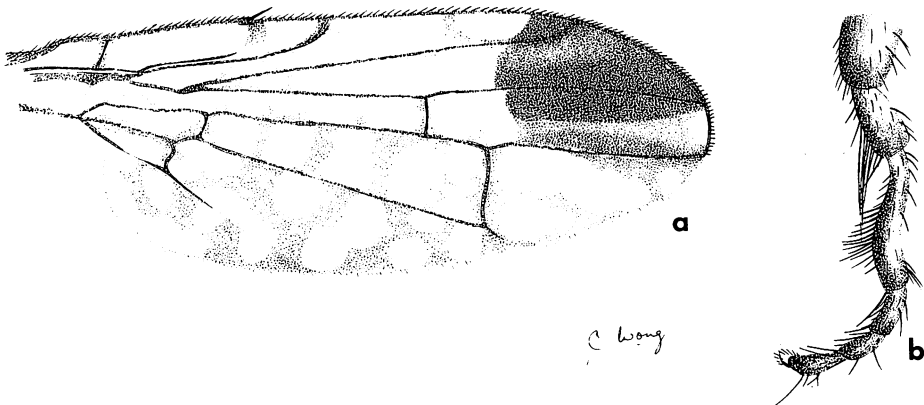


Figure 21—*Trupanea apicalis* Hardy, n. sp.: a, wing; b, front tarsus of male.

with the exception of five or six yellow-white setae in anterodorsal row on basal portion of segment. *Wings*: As noted above and as in figure 21a, with costal cells entirely hyaline and subcostal cell and R_1 almost entirely so. Except for a large anteroapical mark, the wing is hyaline with faint irregular markings of brown. The r-m crossvein is situated more than its length from m crossvein. *Thorax and abdomen*: Shining black in ground color, except for yellow humeri and notopleural calli, densely gray pollinose, and covered with short yellow setae. Fifth tergum with black bristles around margin. The genitalia have not been dissected for study. The long yellow bristles at apices of cerci are very conspicuous *in situ* and are equal or longer than entire abdomen.

Length: body, 2.3 mm.; wings, 2.5 mm.

FEMALE. Fitting description of male except that front tarsi are not modified. Basal segment of ovipositor shining black with yellow-white setae over basal half, black setose on apical portion and just slightly longer than terga 5 + 6. Measured on venter basal segment about .75 mm. long. The piercer has not been extruded for study.

Length, excluding ovipositor, same as male.

Holotype male and allotype female, Pohakuloa, Hawaii, 6500 ft., Jan. 29, 1963 on *Dubautia* (D. E. Hardy). Two male and two female paratypes: Puukihī, Hawaii, 8000 ft., October 1952 (D. E. Hardy); Puulau, Hilo, Hawaii, June 12, 1964 "W. *Cupressus* (Cypress) lvs" (Hu and Fukumura); and Pohakuloa, Hawaii, ± 1800 m., June 21, 1966 (J. W. Beardsley). Also 75 paratypes, both sexes, Mauna Loa, above Pohakuloa, Hawaii, 7300 ft. elevation, swept from blossoms of *Sophora chrysophylla* (Salisb.) Seem., ("Mamane") and *Myoporum sandwicense* (DC.) Gray, ("Naio"), Jan. 12, 1973 (D. E. Hardy).

Type, allotype, and some paratypes in B. P. Bishop Museum; paratypes in U.S. National Museum, British Museum (Natural History), and University of Hawaii collection.

Trupanea arboreae Hardy, new species (figs. 22a-d)

This species shows close relationship to *T. cratericola* (Grimshaw), but differs by having the mesonotum and scutellum yellow-white setose, the palpi yellow, and the wings slightly different in markings as in figures 22a, 27b. In the key it fits near *swezeyi* (Bryan) but is readily differentiated by the dark brown to black femora, the shortened, ornate front basitarsus of the male, the differences in wing markings as shown in figures 22a, 40a, and the more elongate ovipositor base of the female (fig. 22d).

MALE. *Head:* Approximately as long as wide, shaped as in figure 22b, as seen in lateral view. Three pairs of inferior and two pairs of superior fronto-orbital bristles are present. The upper superior fronto-orbitals are yellow-white; the other bristles are black. The inner vertical bristles are black; the outer are yellow-white, flattened. The front is approximately equal in width to one eye, is predominantly opaque to rufous, the eye orbits are cinereous. The antennae are mostly brown to black; the basal segments are tinged with yellow. The arista is dark brown to black, finely pubescent. The palpi are entirely yellow with few short, black setae apically. *Thorax:* Shining black in ground color, densely gray pollinose, entirely white pilose on dorsum and predominantly so on sides, with a few dark setae on hind margin of mesopleuron on upper portions of pteropleuron and sternopleuron. The posterior notopleural bristle is yellow-white, scale-like. *Legs:* Coxae and femora mostly dark brown to black, typically with a faint rufous tinge in ground color. Tibiae and tarsi yellow. Front tibia with numerous short, erect setae extending down dorsal surface. Front basitarsus short and thickened, approximately equal in width to apex of tibia and subequal to second tarsomere; with a dense anteroventral brush, three elongate yellow-white ventral hairs in median portion, and a black anteroventral hair at apex. *Wings:* Costal cells entirely hyaline. Subcostal cell with a large dark brown to black spot extending through basal three-fifths and with apex hyaline. Wing markings are as in figure 22a. The distal hyaline spot in cell R_5 is confined to extreme apex of cell and two round preapical hyaline spots are typically present. Three transverse streaks of brown extend across cell 2nd M_2 . Typically the posterior margin of wing is hyaline from apex of vein $M_3 + 4$ to wing base, lacking an extension of the brown marking in middle of cell M_4 to wing margin. *Abdomen:* Shining black in ground color, rather densely gray pollinose, mostly black setose with yellow-white hairs over the first and second terga and sometimes with scattered yellow-white setae over third and fourth terga, but with conspicuous black setae intermixed. I see no distinct characters in the male genitalia (fig. 22c); the aedeagus terminates in a short tube. Fifth sternum of the male is about one-third wider than long.

Length: body, 3.6 mm.; wings, 3.9 mm.

FEMALE. Fitting description of male except for primary and secondary sexual characters and very similar to *cratericola* except for yellow pilose mesonotum and scutellum and yellow palpi. The wings are similar to those of the male.

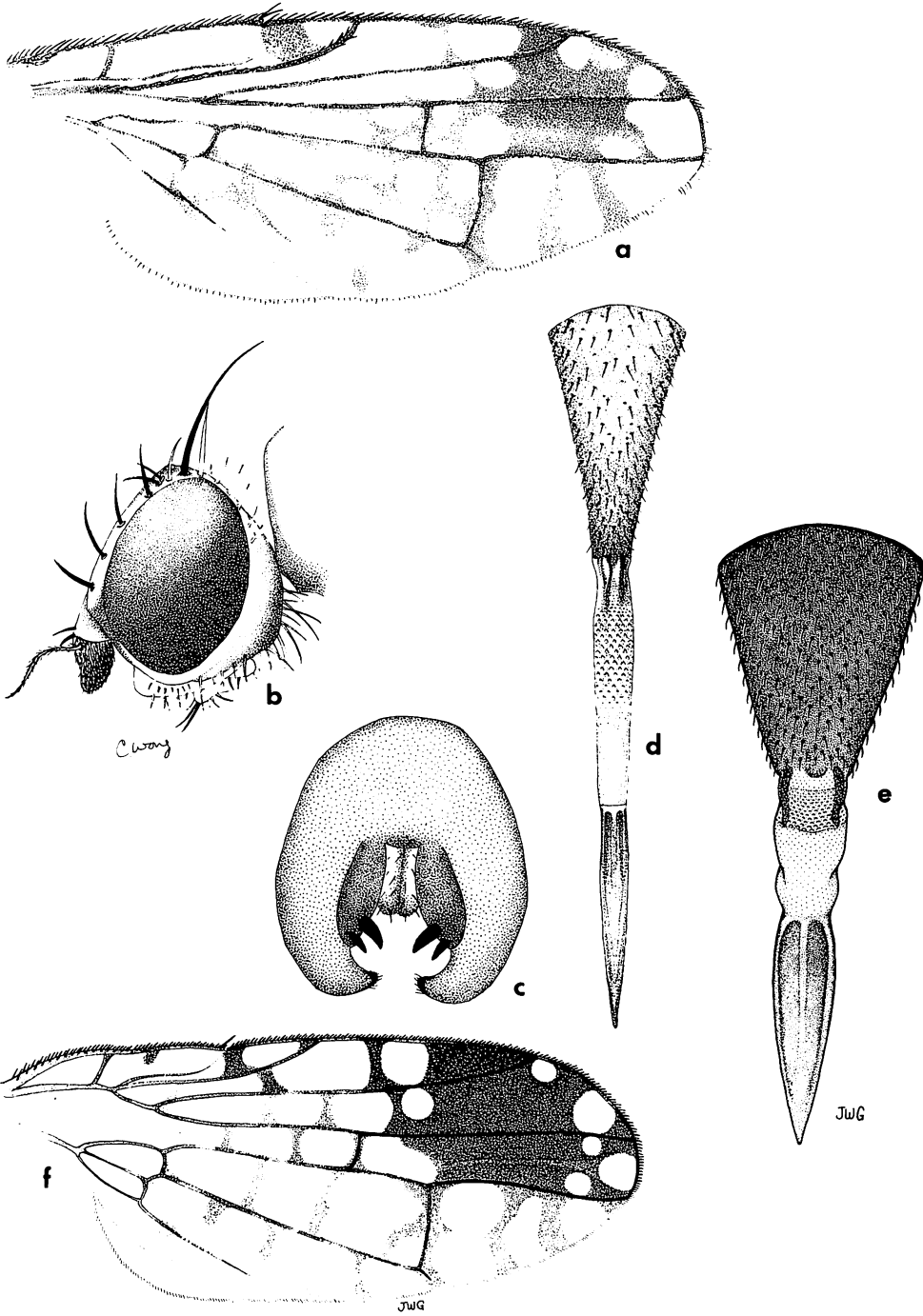


Figure 22—*Trupanea arborea* Hardy, n. sp.: a, wing; b, head, lateral; c, male genitalia; d, female ovipositor. *T. artemisiae* Hardy, n. sp.: e, female ovipositor; f, wing.

The base of ovipositor is approximately equal in length to the last abdominal segments, as in *cratericola* (fig. 22d).

Length: body, 3.6 mm.; wings, 4.3 mm.

Holotype male, allotype female, and 26 paratypes (3 males and 23 females) from Kaula Gulch, above Keanakolu on the northeast slope of Mauna Kea, Hawaii, 7000 ft., October, 1952, reared from "*Railliardia*," = *Dubautia arborea* Gray (D. E. Hardy). 61 paratypes (31 males and 30 females) from Kilauea, Hawaii, bred from "*Railliardia*," = *Dubautia* November 12, 1917 (W. M. Gifford); and from "*Railliardia*," = *Dubautia scabra*, October 10-14, 1929 (O. H. Swezey and R. R. Whitten), one, July, 1903 (R. C. L. Perkins). One female paratype, Mauna Kea, Hawaii, 10,000 ft., December, 1955, reared from "*Railliardia*," = *Dubautia arborea* (J. F. Rock) and two male paratypes from Halapohaku, Hawaii, July 19, 1951 (R. L. Usinger).

A series of 73 specimens are on hand from Kahuku Ranch, Mauna Loa, Hawaii, 5700 ft., August 29, 1972, reared from seeds of Kau silversword, *Argyroxiphium kauense* (Rock and Neal) (J. Jacobi), which certainly seems to be this species. All of the specimens are, however, consistently blacker in appearance. The thorax and abdomen dark gray pollinose appearing black to the unaided eye rather than gray-white and the coxae and femora black rather than dark brown, tinged with yellow to rufous. We find no structural differences in these and the genitalia seem to be alike. This may possibly prove to be a distinct species or subspecies, or may be an incipient species; these specimens are not being designated in the paratype series.

Type, allotype, and some of the paratypes in the B. P. Bishop Museum. The remainder of the paratypes are in the collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

***Trupanea artemisiae* Hardy, new species (figs. 22e-f)**

A small species most closely related to *crassipes* (Thomson), fitting in the grouping of species characterized by having the abdomen, as well as the mesonotum, covered with flattened, scalelike, yellow-white hair; wings with a large preapical dark brown mark with radiating brown bands and with a hyaline spot filling most of apex of cell Sc; also front basitarsus of male lacking long hairs ventrally. It is readily differentiated from other species in this grouping by having the subcostal cell almost all hyaline and basal portions of cells R₃, R₅, 1st M₂, and M₄ with a pattern of narrow, alternating, transverse bands which are discontinuous, not joined into a band over middle of wing (fig. 22f), rather than cell Sc brown with only apex hyaline, or with two small hyaline spots and with a continuous band of brown across the wing at level with cell Sc.

Besides the above characters it differs from *crassipes* by having the mesonotum and scutellum densely gray-white pollinose, not with three brown vittae and the posteromedian portion of mesonotum and often the median portion of the scutellum brownish pollinose. The front basitarsus of the male is

shorter, slightly over $\frac{1}{3}$ to $\frac{2}{5}$ as long as tibia, rather than half as long, and the piercer of the female ovipositor is more slender, evenly tapered, and sharp pointed (figs. 22e, 26b). Otherwise fitting the description of *crassipes*.

Length of male body and wings: 3.0 mm.

Length of female, including base of ovipositor: 3.25 mm.

Holotype male, allotype female, and fourteen paratypes, ten males, four females, Kaupo Gap, Haleakala, Maui, 5800 ft., June 20, 1976, collected on *Artemisia mauiensis* (A. Gray) Skottsberg. Also six paratypes, four males, two females, one mile south of Holua, Haleakala Crater, Maui, 7500 ft., June 4, 1977, collected on *Artemisia* (J. W. Beardsley and G. Teves).

Type, allotype, and some paratypes in the B. P. Bishop Museum. Other paratypes in the collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

The larvae of this species evidently feed in the flowers of *Artemisia*.

***Trupanea beardsleyi* Hardy, new species (figs. 23a-f)**

This species is closely related to *cratericola* (Grimshaw) and occurs in the same habitat as this species. *T. beardsleyi* is differentiated from *cratericola* by having the upper superior fronto-orbital bristles of the male black; the subcostal cell (stigma) entirely dark brown to black; the fifth sternum of the male slightly longer than wide (fig. 23f); and the wing markings distinctly different, as in figure 23a. In *cratericola* the upper superior fronto-orbital bristles are yellow-white in both sexes; the prominent white spot is present at apex of the subcostal cell; the fifth sternum of the male is one-half wider than long (fig. 27g); and the wings are very differently marked as in figure 27d. Also the mesonotum of *beardsleyi* has three faint longitudinal brown vittae; these are lacking on *cratericola*.

MALE. *Head:* Approximately as long as high, shaped as in figure 23c, as seen from a lateral view. Width of gena approximately equal to one-fourth eye height and width of the lower portion of occiput approximately one-third length of eye. Three pairs of inferior and two pairs of superior fronto-orbital bristles present; all are black. Front predominantly rufous, tinged with brown. The eye orbits are gray pollinose. Front approximately equal in width to one eye. Face yellow-white and slightly convex as seen in lateral view. Genae and lower occiput yellow, upper portion of occiput tinged with brown to black. Antennae predominantly brown, third segment tinged with black. Palpi yellow on bases, brown on apices. Labellum yellow, faintly tinged with brown. Lower portion of each gena rather densely covered with black setae. *Thorax:* Shining black in ground color, densely gray pollinose, and with three narrow, indistinct, brown vittae extending full length of mesonotum, one median, and one down each dorsocentral line. Anterior dorsocentral bristles situated just behind suture. Setae of mesonotum black except for scattered white, flattened hairs on posterior portion and on anterior corners. Scutellar bristles strong, nearly two times longer than anterior dorsocentrals. Scutellum bare except for

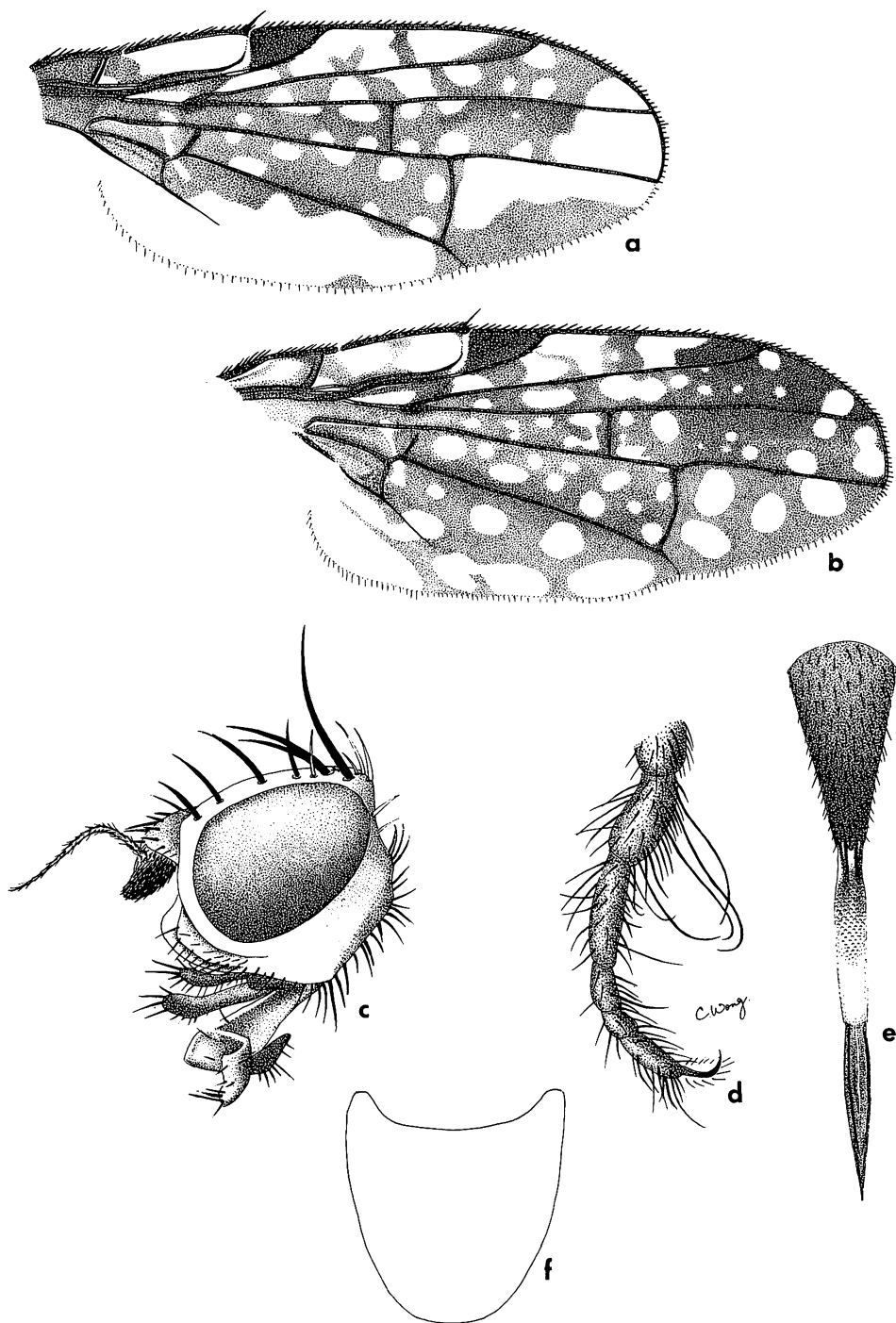


Figure 23—*Trupanea beardsleyi* Hardy, n. sp.: a, wing of male; b, wing of female; c, head, lateral; d, front tarsus, male; e, female ovipositor; f, fifth sternum of male.

some black setae along hind margin. Posterior notopleural bristle scale-like, yellow-white. Mesopleural and sternopleural bristles black, pteropleural bristle yellow-brown. Pleura covered with yellow-white hairs. *Legs*: Coxae and femora predominantly shining black in ground color, covered with gray pollen. Tibiae and tarsi yellow to rufous. Front tibia with numerous short, erect setae extending along dorsal surface. Front basitarsus short and thick, approximately equal in width to apex of tibia and subequal to second tarsomere. Front basitarsus with a number of long ventral and anteroventral hairs as in figure 23d. *Wings*: Distinctively marked as in figure 23a. Costal cells rather indistinctly marked with brown. Subcostal cell entirely brown to black. Cell R_1 hyaline except for a spot of brown beneath subcostal cell, a narrow streak across middle of cell, and except for brown apex. Apical portion of cell R_5 and upper apex of 2nd M_2 hyaline; this extends as a hyaline mark through upper portion of cell 2nd M_2 almost to m crossvein. Lower half of cell 2nd M_2 infuscated; this marking extends as a narrow band along wing margin and apex of cell M_4 . *Abdomen*: Black in ground color, covered with gray pollen, with black bristles along hind margin of fifth tergum, and mostly black setose over dorsum of segments, with yellow-white hairs only on first tergum and scattered on sides of other terga. Fifth sternum equal or slightly longer than wide (fig. 23f); this is plainly visible *in situ*.

Length: body and wings, 3.3–3.6 mm.

FEMALE. Fitting description of male except that wing markings are distinctly different and front tarsi are not modified. The wings are much more spotted as shown in figure 23b. Cell 2nd M_2 has three hyaline spots, etc. Hind margin of wing is infuscated from apex of vein $M_1 + 2$ to slightly beyond vein $Cu_1 + 1st A$. Basal segment of ovipositor elongate, shining black, about equal in length to terga three to six. Basal segment 1.7 mm. long. The piercer is slender, sharp-pointed, 1.5 mm. in length (fig. 23e); extended ovipositor measures 4.5 mm.

Length: body, excluding ovipositor base, 3.6 mm.; wings, 4.0–4.3 mm.

Holotype male, Halemanu Trail, East Maui, 8000 ft., May 1, 1945 (E. C. Zimmerman). Allotype female, Haleakala, Maui, 10,000 ft., September, 1956, ex. "*Railliardia*," = *Dubautia* (J. W. Beardsley). Forty-one paratypes, sexes about evenly distributed from the following localities on Haleakala, Maui: same as type and allotype, some reared from *Dubautia*, 10,000 ft., Jan. 27, 1963 (J. W. Beardsley); October, 1951, collected on *Coprosma* and *Cyathodes* (E. Bryan and H. A. Bess); Paliku, Haleakala Crater, 6500 ft., June, 1952–June, 1953 (C. R. Joyce and D. E. Hardy); Holua, Haleakala, collected sweeping on *Styphelia* July 25, 1963 (D. E. Hardy); and Puu Ni-aniau, 7000 ft., July, 1956 (R. Namba).

Type, allotype, and some of the paratypes deposited in the B. P. Bishop Museum collection. The remainder of the paratypes are in the following collections: U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

This species is named after Dr. J. W. Beardsley, Dept. of Entomology, University of Hawaii, who has made outstanding contributions to our knowledge of native Hawaiian insects.

***Trupanea bidensicola* Hardy, new species (figs. 24a-b)**

This species fits very close to *crassipes* (Thomson) and has been confused with this species in the past. The specimen recorded from Kauai, as *crassipes*, by Grimshaw (1901:45), probably was *bidensicola*. The only characters which I can find for separating these is the wing markings, the difference in the markings on the mesonotum, and the fact that the female ovipositor is more pointed at the tip in *bidensicola* than in *crassipes* (figs. 24b, 26b). In *bidensicola* the subcostal cell has two prominent hyaline marks and the entire basal half of the wing is covered with clearly defined hyaline spots (fig. 24a). In some female specimens a hyaline mark extends almost the full length of cell Sc along the costal margin, not being clearly divided into two spots. The mesonotum is entirely gray pollinose and lacks the yellow-brown markings found on *crassipes*. We find no distinctive features on the legs; they appear to be exactly like those of *crassipes*. Also, the body chaetotaxy and other details appear to be the same in the two species. I find no apparent differences in the male genitalia or in the characters of the male sterna. The seventh segment of the female is approximately equal in length to segments five plus six; the basal half of the seventh is covered with yellow-white scales, the apical portion with brown hairs. The female ovipositor is as in figure 24b, piercer sharply tapered into a slender point, 0.75 mm. long; extended ovipositor is 2.5 mm.

Holotype male and allotype female from Kumuwela, Kauai, June 19, 1952, reared from flower heads of *Bidens cosmoides* (O. H. Swezey). Twelve paratypes (6 males and 6 females) from the following localities on Kauai: same data as type; same locality as type, August 3, 1925, ex "*Campylothea* sp.?" (= *Bidens*); one labeled "2500 feet, Kauai, April 8, 1919" (J. A. Kusche); Kokee, August, 1955 (R. H. van Zwaluwenburg) and Kokee, 3600 ft., July, 1952-August, 1953 (D. E. Hardy) and Kaholuamanu, May 10, 1920 (J. A. Kusche).

Type and allotype, and some paratypes in the B. P. Bishop Museum. Other paratypes in the U.S. National Museum, British Museum (Natural History), and the University of Hawaii collection.

***Trupanea celaenoptera* Hardy, new species (figs. 25a-d)**

Because of the unusual wing markings this species fits in a complex with *nigripennis* n. sp. which differ from all known *Trupanea* by having the wings almost entirely brown, lacking hyaline spots except for a few on the margin (figs. 25a, 36b). On the basis of wing markings, these two species would appear to be generically distinct from *Trupanea*; but in view of the extreme variability found in Hawaiian species, we feel that this is only a species group character.

This species is closely related to *nigripennis* n. sp. but differs by having the legs yellow; thorax and abdomen yellow setose; wings light brown with indistinct hyaline spots in lower half of cell M₄ and with cell R₃ all brown; and front basitarsus much shorter, one-fourth as long as tibia and shorter than second tarsomere, bearing numerous long ventral hairs (fig. 25c).

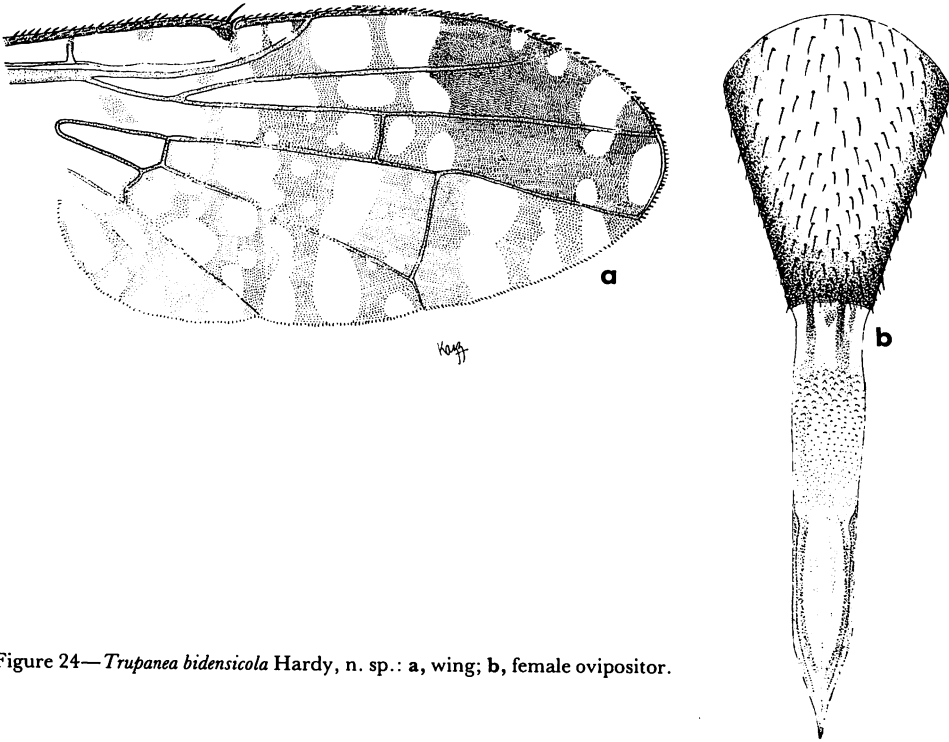


Figure 24—*Trupanea bidensicola* Hardy, n. sp.: a, wing; b, female ovipositor.

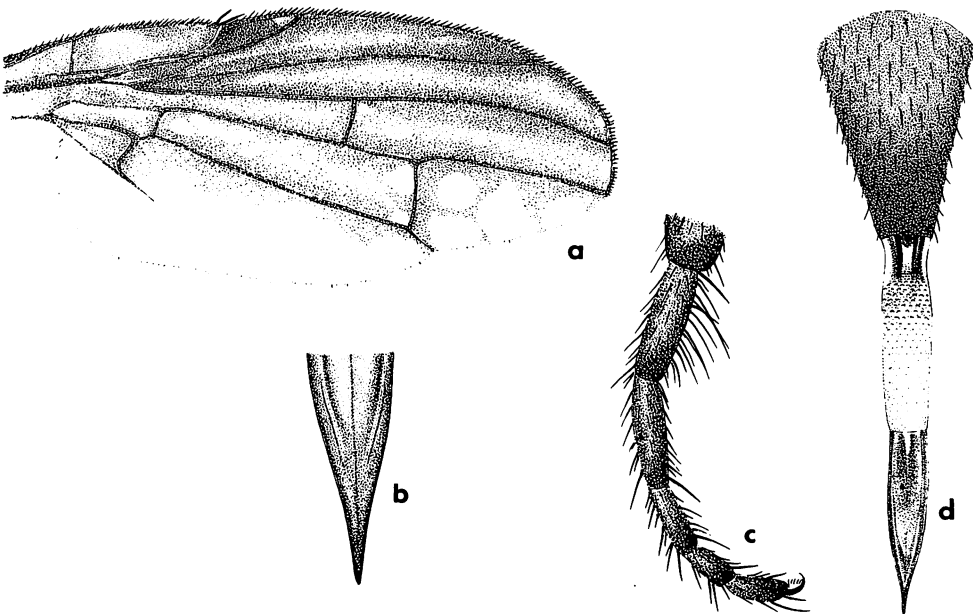


Figure 25—*Trupanea celaenoptera* Hardy, n. sp.: a, wing; b, apex of female piercer; c, front tarsus of male; d, female ovipositor.

MALE. *Head:* Similar in shape to other *Trupanea* except that the orbits are slightly bulged on lower front as seen from lateral view. Approximately as high as long with face concave in profile. Yellow except for a pair of large, brown, submedian spots on upper hind portion of occiput, and the black ocellar triangle. Front approximately as wide as long, rather densely gray pollinose especially along sides. Three pairs inferior fronto-orbitals and two pairs superior fronto-orbitals; the upper are yellow-white. Genae densely yellow setose, genal bristle brown, short, scarcely differentiated from other setae. Antennae yellow, tinged with brown over third segment; the latter short and round, about one-half longer than wide. Arista short, scarcely longer than antennae. *Thorax:* Dark brown to black in ground color, yellow on humeri, entirely yellow-white setose and with ground color completely obscured by the dense covering of gray pollen. All bristles brownish yellow except for pale yellow-white posterior notopleurals. Halteres yellow, tinged slightly with brown on knobs. *Legs:* Entirely yellow, front tarsi as noted above and as in figure 23c. *Wings:* As noted above and as shown in figure 23a. Vein $R_4 + 5$ bare except for one seta at its base above. *Abdomen:* Entirely black in ground color, densely gray pollinose and covered with short, yellow setae. Fifth tergum with a few yellow-brown bristles on hind margin. Fifth sternum approximately twice as wide as long; the hind margin is gently concave.

Length: body and wings, 4.0–4.2 mm.

FEMALE. Fitting description of male in most respects. Sixth tergum equal in length to fifth. Basal segment of ovipositor polished black, as seen from dorsal view about equal in length to terga four to six. Measured on venter the basal segment is 1.7 mm. in length. Piercer narrowed to a long, slender point at apex and 1.2 mm. in length (figs. 25b, d). Extended ovipositor measures 4.0 mm.

Length: body, 4.2 mm.; wings, 4.4 mm.

The parasite *Euderus metallicus* (Ashmead) (Eulophidae), has been reared from the galls caused by this species.

Holotype male, allotype female, and six paratypes, 4 males, 2 females: Pohakuloa, Hawaii, 6500 ft., reared from gall on stems of *Dubautia*, January 1963 (D. E. Hardy).

Type and allotype in B. P. Bishop Museum. Paratypes in collection of University of Hawaii, British Museum (Natural History), and U.S. National Museum.

***Trupanea crassipes* (Thomson) (figs. 26a–c)**

Trypeta crassipes Thomson, 1869, in K. svenska Fregatten Eugénies Resa, Zool. 2:583. Type-locality: Honolulu.

Endemic, Oahu. Common over all of the main Hawaiian Islands, except Kauai.

Hosts: These breed commonly in the flower heads of *Bidens pilosa* Linnaeus throughout the lowlands and evidently breed in the flowers of native *Bidens*,

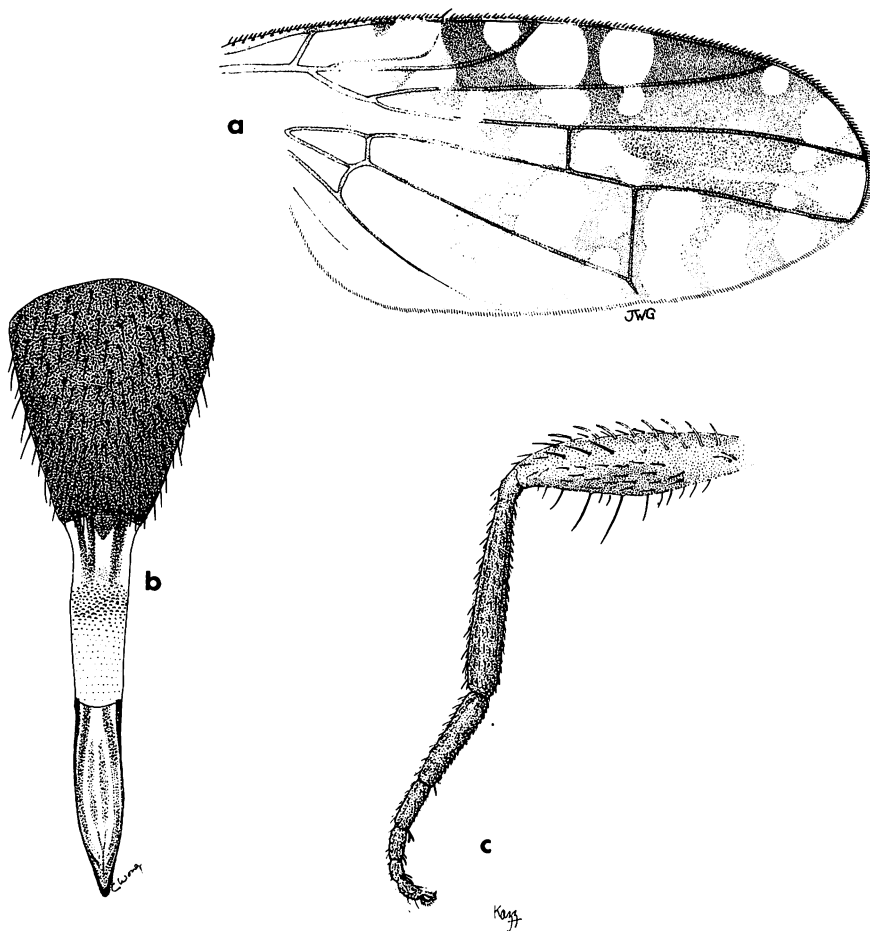


Figure 26—*Trupanea crassipes* (Thomson): a, wing; b, female ovipositor; c, front leg, male.

Dubautia, and possibly over Compositae in the higher areas throughout the islands. Large numbers of specimens have been taken in Haleakala Crater (6500–7200 ft.), Maui, and on the slopes of Hualalai, Hawaii, up to 8000 ft. elevation sweeping *Styphelia*, *Dubautia*, and other shrubs. The adults obviously frequent plants which are not necessarily hosts for the immature stages.

This species appears to be related to *T. dubautiae* (Bryan) but differs by having the front basitarsus of the male rather elongate, approximately one-half as long as tibia (fig. 26c), and by the differences in wing markings as shown in figures 26a, 30c. It is also near *bidensicola* n. sp., from Kauai, but is readily differentiated by the single, apical, hyaline spot in cell Sc; by the presence of brown vittae, and a posteromedian brown marking on the mesonotum; and by having the basal half of wing with large irregular hyaline areas (fig. 26a).

Mesonotum densely gray pollinose with three indistinct longitudinal brown

vittae. Vestiture of thorax and abdomen entirely yellow-white. The head characters are similar to those of other *Trupanea* with three pairs inferior fronto-orbitals, and the upper superior fronto-orbital bristles yellow. The legs are entirely yellow; the basitarsus of the front pair, in the male, is characteristically elongated and lacks long ventral setae (fig. 26c). Front basitarsus approximately one-half as long as tibia and about two times longer than second tarsomere. The wings are characterized by having cell Sc brown, except for a prominent hyaline apical or preapical spot, and by having an apical hyaline mark in cell R₅. A large preapical fuscous spot with radiating bands is present in wing and the other markings are as in figure 26a. I see no distinctive features in the male genitalia. The fourth and fifth abdominal sterna are distinctly wider than long. On the female segment seven (the basal segment of ovipositor) is about equal in length to segments five plus six, as seen from dorsal view. The basal half of segment seven is covered with yellow-white scales and the apical half with dark hairs. The ovipositor is characteristically broad and thick. The piercer is just slightly over three times longer than wide, is rather blunt (fig. 26b), measures 0.65 mm., and is approximately equal in length to the preceding segment. The extended ovipositor measures 2.0 mm.

Length: Male, body and wings, 3.2–3.6 mm. Female, body, not including ovipositor, 3.2–3.9 mm.; wings, 3.5–4.0 mm.

***Trupanea cratericola* (Grimshaw) (figs. 27a–g)**

Tephritis cratericola Grimshaw, 1901, Fauna Hawaiiensis 3:46. Type-locality: Haleakala, 8000 ft.

Endemic, Maui.

This species is known only from Haleakala; most of the specimens have been taken inside of the crater. It was first collected in April 1894 (by R. C. L. Perkins).

Hosts: Infesting the flower heads of silversword (*Argyroxiphium sandwicense* D.C.), also *Dubautia* (*Railliardia*) sp. The adults are often taken in large numbers sweeping *Styphelia* and other shrubs in the crater.

This species is characterized by having predominantly black setae over the mesonotum and abdomen, the femora dark brown to black, basal segment of ovipositor (seventh segment of the female abdomen) elongate, and wings characteristically marked, as in figures 27a, d. It fits near *T. beardleyi* n. sp. but is differentiated by having the upper superior fronto-orbital bristles yellow-white; by having a prominent hyaline spot at apex of cell Sc; cell 2nd M₂ with three narrow brown to black transverse stripes extending to margin and other wing markings as in figure 27d; also, by having the fifth sternum of male one-half wider than long, rather than as long as wide (figs. 23f, 27g).

Mesonotum black pilose except for yellow-white, scale-like hairs confined to margins. Vestiture of abdomen almost completely black. Antennae entirely dark colored, brown to black. Front predominantly rufous, tinged faintly with brown through median portion, gray on orbits. Face densely gray pollinose.

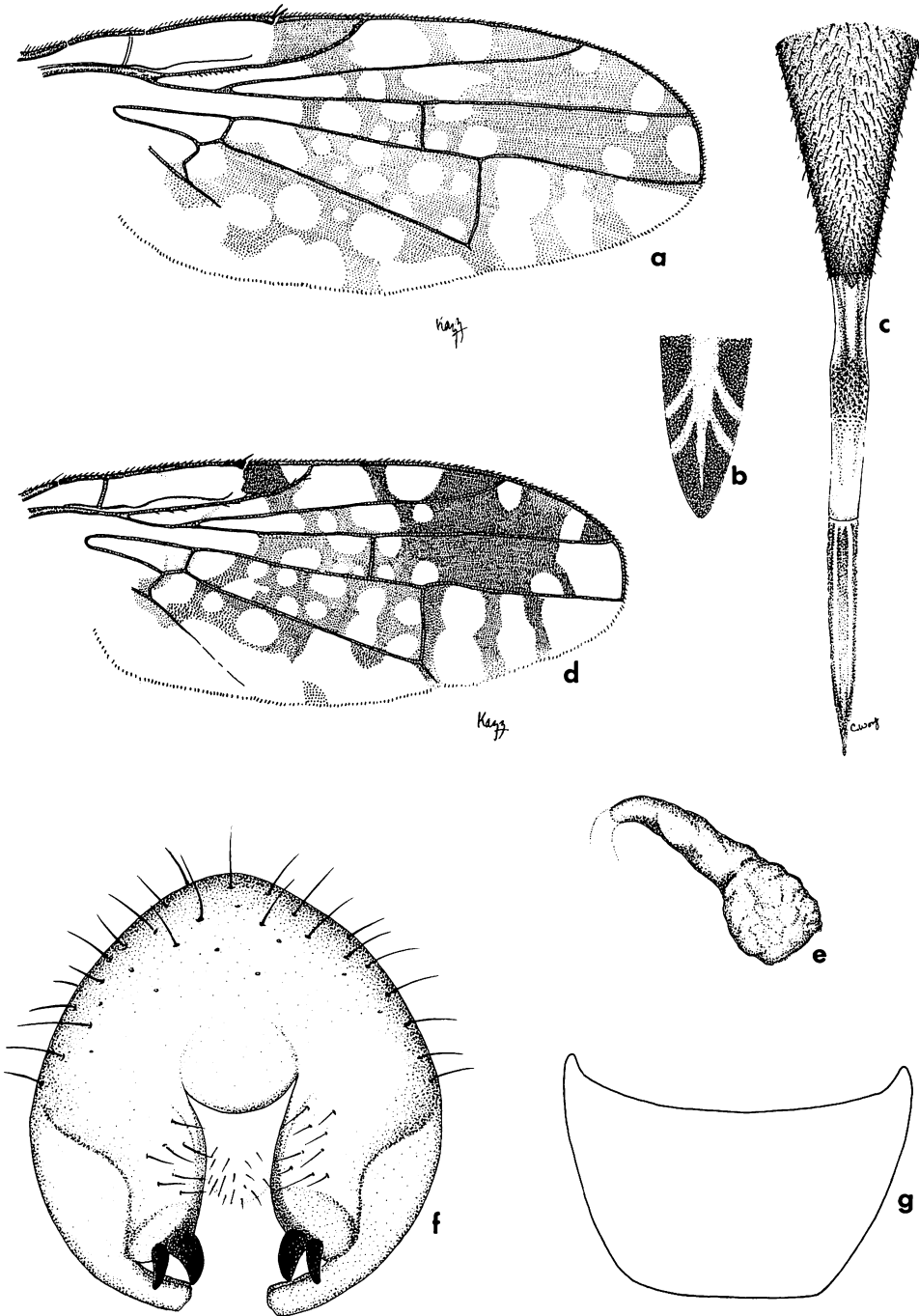


Figure 27—*Trupanea cratericola* (Grimshaw): a, wing of female; b, apex of female piercer; c, female ovipositor; d, wing of male; e, female spermatheca; f, male genitalia; g, fifth sternum of male.

Genae yellow to rufous in ground color, faintly tinged with brownish and covered with gray pollen. Occiput predominantly brown to black, covered with gray pollen. Palpi brown to black at apices and labella tinged with brown. Thorax entirely gray pollinose; three rather indistinct dull black vittae extend down mesonotum. Humeri brown to black in ground color. Hind margin of scutellum black setose. Halteres brown on knobs, yellow on bases. Coxae and femora brown to black, tibiae mostly brown to black, tinged with yellow at apices. Tarsi yellow, faintly tinged with brown. Front basitarsus short, and slightly thickened, and with very long ventral hairs. Basitarsus scarcely one-fifth to one-sixth as long as tibia and distinctly shorter than second tarsomere. Front tibia and tarsus with short, erect dorsal setae. Considerable sexual dimorphism is evident in the wing markings. The male has the apices of cells R_5 and 2nd M_2 hyaline (fig. 27d). In the female a brown mark extends along apices of veins $R_4 + 5$ and $M_1 + 2$, isolating a hyaline spot at apex of cell R_5 (fig. 27a). The other wing markings are as in the above noted figures. The fifth and sixth sterna of the male are distinctly wider than long. The genitalia are as in figure 27f. The basal portion of the female ovipositor is elongate, approximately equal in length to segments two-six and measuring approximately 2.2 mm.; the entire ovipositor is 5.7 mm. The inversion membrane (eighth segment) measures approximately 1.75 mm.; the piercer measures 1.9 mm. and is sharply pointed at apex (figs. 27b, c). Spermathecae shaped as in figure 27e.

Length: Male, body and wings, 4.3 mm. Female, body, not including the ovipositor, 4.0 mm.; wings, 4.65 mm.

***Trupanea dempta* Hardy, new species (figs. 28a-d)**

Fitting near *pekeloï* n. sp., from Molokai, but differing by having the second costal cell predominantly hyaline with only two small brown marks on margin, not extending over cell; by the front basitarsus of male about two times longer than second tarsomere and with only a few long ventral hairs; posterior portion of wing hyaline on margin (fig. 28c); and base of ovipositor equal in length to terga four to six and with white setae over basal half. *T. pekeloï* has two prominent brown marks in second costal cell, extending over most of cell, and has brown markings continuing to margin through posterior portion of wing (fig. 38a); the basitarsus is about equal in length to second tarsomere and bears a clump of long ventral hairs; also, tarsomere one to four each has a long, curved, apical or preapical, anterior cilium—these are lacking on *dempta*; the basal segment of ovipositor of *pekeloï* is equal to terga five plus six and the white setae extend over basal two-thirds of that segment.

MALE. Head: Slightly narrowed anteriorly as seen from direct lateral view (fig. 28d), entirely yellow except for discoloration of brown in ground color of upper median portion of occiput, black ocellar triangle, and tinge of orange in ground color of front. Front about as wide as long, rather densely gray pollinose, especially on sides and down median portion. Bristles rather short, except for inner verticals which are about equal in length to postocular setae;

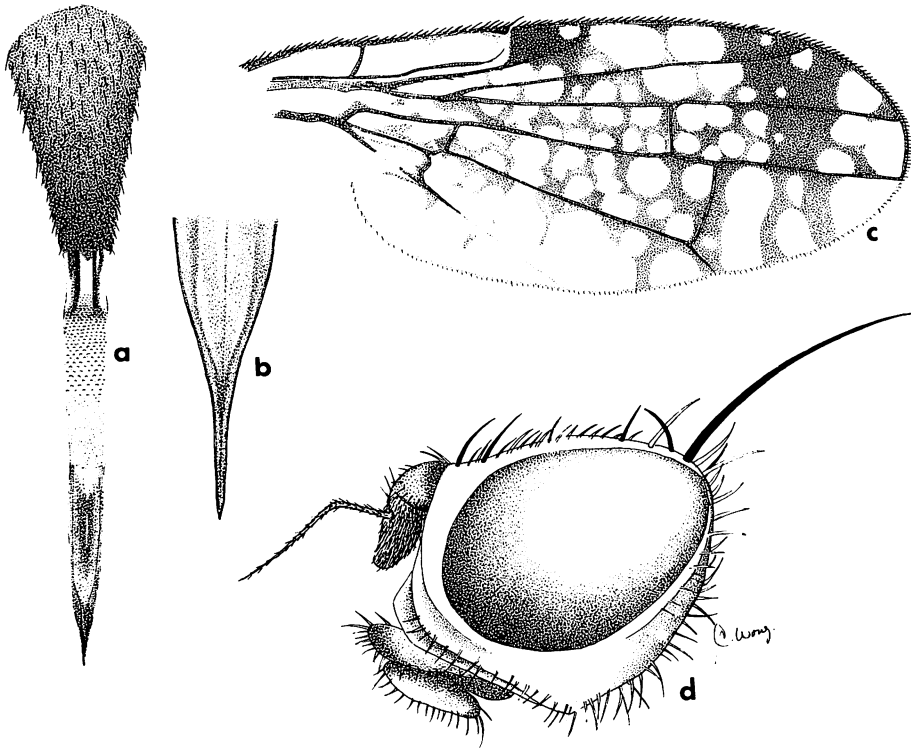


Figure 28—*Trupanea dempta* Hardy n. sp.: a, female ovipositor; b, apex of piercer; c, wing; d, head, lateral.

upper superior fronto-orbitals yellow, tinged with brown. Epistomal margin very prominent. Genae with short, brown setae over front portion and with yellow and a few brown to black setae intermixed on hind portion; genal bristle not differentiated. Antennae, palpi, and mouthparts yellow. Third antennal segment about one-half longer than wide, broadly rounded at apex. Arista bare or nearly so. *Thorax*: Black in ground color except for tinge of yellow on humeri, densely gray pollinose and short, yellow-white pilose. All bristles black except for yellow notopleurals. Halteres yellow with a faint tinge of brown on knobs. *Legs*: Yellow to rufous, front tarsi lacking long anterior cilia on tarsomeres. Legs entirely black setose. *Wings*: Marked as in figure 28c. Apices of cells R_5 and 2nd M_2 , hyaline and R_3 largely hyaline at apex. Two large hyaline marks in basal portion of fourth costal section extend through most of cell R_3 and posterior margin of wing largely hyaline. *Abdomen*: Black in ground color, densely gray pollinose, and thickly covered with yellow-white setae, with black bristles on lateral margins of terga and along hind margin of fifth tergum. Fifth sternum over two times wider than long, moderately concave on posterior margin. Male genitalia with phallic apodeme well developed, flattened, heavily sclerotized, and black in color.

Length: body and wings, 3.8–4.0 mm.

FEMALE. Fitting description of male except for sexual characters, also the frontal and ocellar bristles are distinctly larger than in the male. Basal segment of ovipositor equal in length to terga four to six. White setose over basal half and with apical portion covered with black setae. Measured on venter, the basal segment is 1.75 mm. long. Piercer tapered to a long slender point at apex (figs. 28a, b) and measures 1.4 mm. in length. Extended ovipositor measures 4.5 mm.

Length: body, 4.0 mm.; wings, 4.25 mm.

Holotype male and allotype female, Kilauea, Hawaii, 4000 ft., June 22, 1966 (J. W. Beardsley). 12 paratypes, 11 males, 1 female, mostly from Kilauea collected June–October, 1929–1969. Two specimens labeled Kau, 4000 ft., no date or collector and one Kau desert, Kilauea, Hawaii, 3800 ft., (D. T. Fullaway), September 13, 1919, and one specimen Hualalai, Hawaii, October 19, 1963 (D. E. Hardy). Some of the specimens were collected on “*Railliardia*” (= *Dubautia*), and some on *Dodonaea*.

Type, allotype, and some paratypes in B. P. Bishop Museum. Remainder of paratypes in collections of U.S. National Museum, British Museum (Natural History), and University of Hawaii.

***Trupanea denotata* Hardy, new species (figs. 29a–e)**

This species fits near *joycei* in the key because of the black setose thorax and abdomen and the abundance of hyaline spots on the wings. The two are apparently not closely related and, because of the nature of the front tarsi of the male, would fall in different species groups. *T. denotata* is differentiated by having the antennae entirely black; wings lacking hyaline spots in 2nd costal cell and not having apices of cells R_5 and 2nd M_2 hyaline; mesonotum with brown to dull black vittae on anterior half; and front basitarsus nearly two times longer than second tarsomere, and with short ventral hairs (fig. 29a). *T. joycei* has the antennae yellow; wings with two hyaline spots in second costal section and apices of cells R_5 and 2nd M_2 hyaline (fig. 31c); mesonotum all gray, lacking vittae; front basitarsus much shorter than second tarsomere and with long ventral hairs (fig. 31b).

FEMALE. *Head*: Shaped as in other *Trupanea*, with the occiput moderately swollen below, at widest point approximately half the width of the eye. Genae densely black setose, genal bristle just slightly larger than surrounding setae. Front orange-yellow, densely gray on sides and over ocellar triangle. Lunule yellow in ground color, densely gray pollinose. Antennae black except for extreme apices of second segment which are yellow. Arista almost bare. Palpi and mouthparts yellow. Eyes brilliant green in live specimens. *Thorax*: Black in ground color except for yellow humeri and halteres. Densely gray pollinose except for a marking of brown over mesonotum; this brown pattern covers posteromedian portion bordered by a level with scutellar bristles on sides and extending to a level with supraalar bristles, then extending to anterior margin

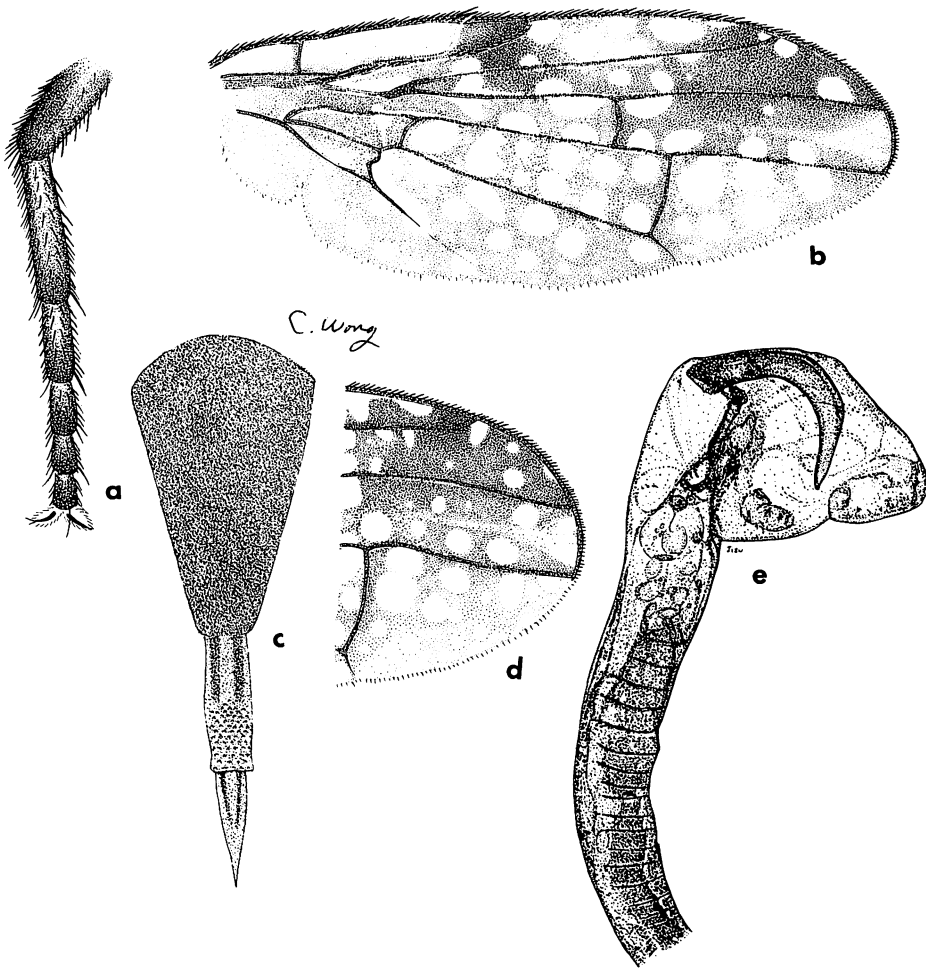


Figure 29—*Trupanea denotata* Hardy, n. sp.: a, front tarsus of male; b, wing of male; c, female ovipositor; d, apex of wing of female; e, apex of male aedeagus.

as three brown vittae, one median and one down each dorsocentral line. Mesonotum entirely black setose except for a few scattered yellow setae along sides. Pleura yellow-white setose except for numerous black setae extending over posterior edge of each mesopleuron. All thoracic bristles black (posterior notopleurals missing). Each sternopleuron with a pair of rather prominent black bristles on posteroventral margin. *Legs*: Entirely yellow, front femur with a row of black posterodorsal setae extending from apex to basal four-fifths, with white setae continuing in the row to base of segment. With a row of white setae extending along anterodorsal surface from base of segment to apical four-fifths and with two black setae continuing in this row. Also with about six moderately strong posteroventral bristles extending over apical

three-fifths of segment. *Wings*: As in figure 29d. *Abdomen*: Black in ground color, densely gray pollinose, covered with fine yellow setae over first tergum and base of second, otherwise black setose and with black bristles at apices of terga. Basal segment of ovipositor polished black, as seen from above equal in length to terga 4-6; measured on venter, the basal segment is 1.7 mm. long. The ovipositor has not been fully extended for study; the piercer is visible *in situ*, however, and the apex is narrowed gradually to a long slender point (fig. 29c). The piercer measures approximately 1.0 mm. and the extended ovipositor would probably measure 4.3 mm.

Length: body, 4.5 mm., excluding ovipositor; wings, 4.75 mm.

MALE. Fitting description of female in most respects. Front basitarsus almost two times longer than second tarsomere and with some short erect basal setae (fig. 29a). The wing differs by having slightly fewer hyaline spots, especially in the apical half of the wing (compare figures 29b and 29d). The genitalia are similar to those of other *Trupanea* except that the aedeagus ends in a curved, nearly hook-like process (fig. 29e).

Length: body, 4.0 mm.; wings, 4.2 mm.

Holotype female, Haleakala, Maui, Kolekole Peak, 10,000 ft., on "*Railliardia*" (= *Dubautia menziesii* Gray, February 21, 1964 (J. W. Beardsley). Allotype male, Haleakala, Maui, 10,000 ft., ex *Dubautia*, January 27, 1963 (J. W. Beardsley). Forty-two paratypes: 24 males, 18 females, Upper Hana Forest, Maui, 5600 ft., July-August, 1973, collected on and reared from growing tips of greensword, *Argyroxiphium virescens* var. *paludosa* St. John (D. E. Hardy, C. W. Whittle, and S. L. Montgomery).

Type, allotype, and some paratypes in B. P. Bishop Museum. Other paratypes in U.S. National Museum, University of Hawaii, and British Museum (Natural History).

This species breeds in the growing tips of greensword and possibly also in *Dubautia*.

***Trupanea dubautiae* (Bryan) (fig. 30a-d)**

Tephritis dubautiae Terry, 1912, Proc. Haw. Ent. Soc. 2:147. *Nomen nudum*.

Tephritis dubautiae Bryan, 1921, Proc. Haw. Ent. Soc. 4:477. Type-locality: Ohulehule, Koolau Mts., Oahu.

Endemic. Oahu, Kauai, Maui. Found rather abundantly in both the Waianae and Koolau Mountains on Oahu and also in the Kokee and Alakai Swamp area on Kauai.

Hosts: Infests flower heads of *Dubautia plantaginea* Gaud., probably other *Dubautia*, and "*Railliardia*" (= *Dubautia arborea* Gray. Bryan (1921:478) also recorded it from "*Campylothea*" (= *Bidens*).

This is a small species which is similar to *crassipes* because of the yellow pile on mesonotum and abdomen. It differs strikingly, however, by the wing markings (figs. 26a, 30c); by the short front basitarsus of male (fig. 30d); presence of strong bristle on each male cercus; as well as by other details.

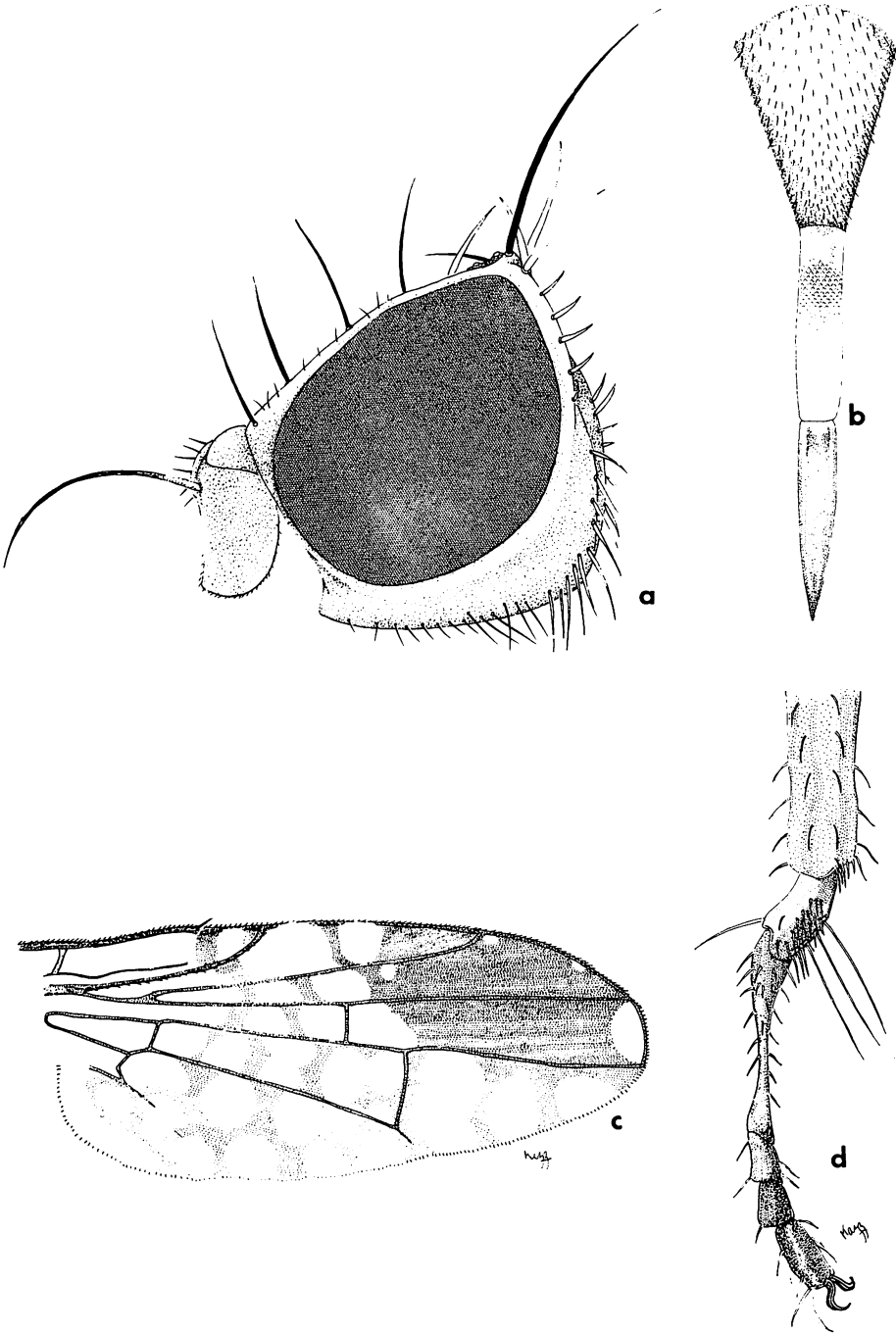


Figure 30—*Trupanea dubautiae* (Bryan): a, head, lateral; b, female ovipositor; c, wing; d, front tarsus of male.

This species conforms in general characteristics to *crassipes*, differing as noted above. The head is approximately as high as long. The thorax is densely gray pollinose, lacking brown vittae on mesonotum. The halteres are yellow. The legs are entirely yellow. The front basitarsus is short, thickened, and bears long ventral hairs (fig. 30d). The wing markings are similar in both sexes and are as in figure 30c. The subcostal cell is largely hyaline, bordered with brown at apex and at base. The anteroapical portion of wing is extensively brown; this marking fills all of the apical two-fifths of cell R_1 . Cell R_5 has a hyaline spot at apex; this is bordered by brown along veins $R_4 + 5$ and $M_1 + 2$. The other details of wing markings are as in figure 30c. The fifth and sixth sterna of male are distinctly wider than long. The basal segment of female ovipositor is shining brown, tinged with rufous. As seen from dorsal view, it is approximately equal to segments four to six; the basal two-fifths is covered with yellow-white scales and the apical portion with dark hairs. The entire ovipositor is approximately 2.8 mm. long (fig. 30b); the base (segment seven) is 1.05 mm.; the inversion membrane (eighth segment) measures 0.9 mm.; and the piercer measures 0.9 mm. and is gradually tapered to a sharp point at apex.

Length: Male body, 2.3 mm.; wings, 2.7 mm. Female body, 2.5 mm.; wings, 3.0 mm.

***Trupanea joycei* Hardy, new species (figs. 31a-d)**

This species fits in the group which is characterized by having predominantly black hair on the mesonotum and abdomen. Superficially, because of the large oblong eyes and the wing markings, it would resemble *limpidapex* (Grimshaw) but the two do not appear to be closely related. The differences in the vestiture of the body and the marked differences in wing patterns will readily differentiate these: the wing of *joycei* is more mostly brown with fewer spots, the subcostal cell is almost entirely brown, etc. (see figs. 31c, 32a). It runs nearest to *beardsleyi* and *cratericola*, both from Maui, but is differentiated by having the femora, antennae, and palpi yellow to rufous rather than brown to black; the wings very differently marked (figs. 23a, 27a); and the base of female ovipositor comparatively short.

MALE. *Head:* Approximately as high as long, as seen in profile the face is slightly concave and the epistoma prominent. Genae rather densely black setose and occiput covered with yellow-white scales. Front rufous, faintly tinged with brown; the orbits are gray pollinose and the lunula yellow-gray. Upper superior fronto-orbital bristles black. Antennae yellow to rufous, faintly tinged with brown. Palpi and mouthparts yellow; each palpus has numerous short black setae around apex. *Thorax:* Densely gray pollinose, predominantly black setose on dorsum, yellow-white setose on pleura except for some brown to yellow-brown hairs on posterior margin of each mesopleuron and on upper portion of each pteropleuron. Halteres yellow. *Legs:* Entirely yellow except for a tinge of brown on coxae. Front tibiae and tarsi densely covered with erect

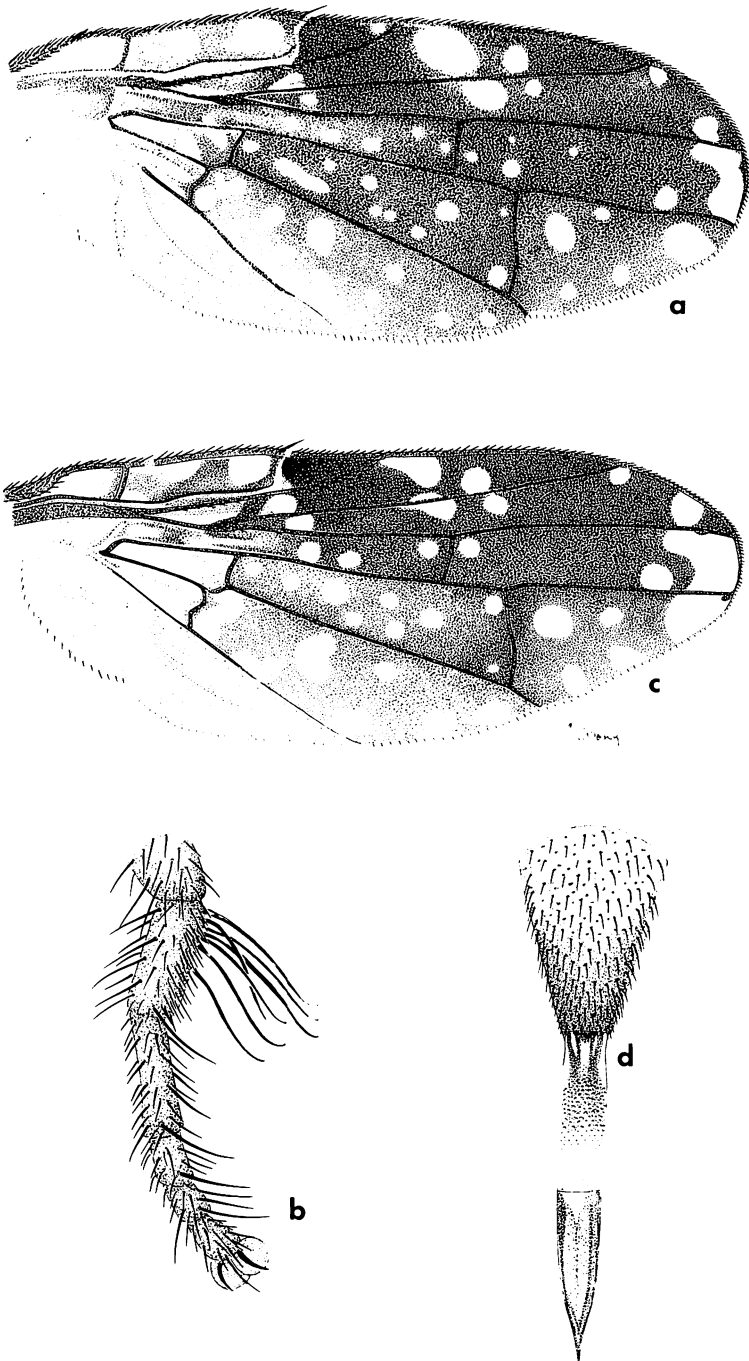


Figure 31—*Trupanea joycei* Hardy, n. sp.: a, wing of female; b, front tarsus of male; c, male wing; d, female ovipositor.

dorsal setae. Front basitarsus short and thick, and bears elongate ventral hairs (fig. 31b). Basitarsus one-fourth to one-fifth as long as tibia and slightly shorter than second tarsomere. Tarsomeres one to four each have a moderately long, black, anterodorsal hair at or near apex. *Wings*: Mostly brown, with rather scattered, small, round, hyaline marks. Subcosta almost completely dark brown and apices of cells R_5 and $M_1 + 2$ hyaline (fig. 31c drawn from paratype). Considerable variation in arrangement of the hyaline spots is evident in the series at hand; no two specimens are exactly alike. *Abdomen*: Gray pollinose, covered with black hairs and with some yellow pile on first two terga and on base of third tergum. The genitalia have not been dissected for study.

Length: body, 5.0 mm.; wings, 5.4 mm.

FEMALE. Fitting description of male in most regards; some sexual dimorphism is evident, however, in the wing markings. The ovipositor base is polished black, completely covered with black setae and approximately equal in length to abdominal segments five-six. Measured on ventral portion, *in situ*, the base of ovipositor is approximately 2.4 mm. The entire ovipositor (fig. 31d) measures approximately 5.0 mm.

Length: body, excluding ovipositor, and the wings, 5.7 mm.

Holotype male, Aina Haina, Oahu, January 1, 1961 (C. R. Joyce). Allotype female, Nuuanu Valley, Oahu, January 20, 1959, in light trap (C. R. Joyce). Six paratypes: one male, Olympus, Oahu, November 21, 1909 (O. H. Swezey); one female, Puu Kukui, Maui, 3000-4500 ft., June, 1953 (D. E. Hardy), and two males and two females, Pepeopae, Molokai, 4000 ft., July 30, 1959 (D. E. Hardy).

Type and allotype in the B. P. Bishop Museum. Paratypes in U.S. National Museum and the collection of the University of Hawaii.

***Trupanea limpidapex* (Grimshaw) (figs. 32a-d)**

Tephritis limpidapex Grimshaw, 1901, Fauna Hawaiiensis 3(2):46, pl. 2, fig. 24. Type-locality: Haleakala Crater.

Endemic. Maui. To date the species has been taken only on Mt. Haleakala or in the crater of Haleakala at elevations ranging from 6400-10,000 ft.

Hosts: This has been reared from the flower heads of *Dubautia* (*Railliardia*) sp.

This species belongs in the group which is characterized by the great abundance of small, hyaline spots scattered over the wing membrane, and by having all yellow-white pile over mesonotum and abdomen. It fits closest to *T. pantosticta* n. sp., from Hawaii, but differs by having apices of cells R_5 and M_2 hyaline and the wing markings as in figure 32a. Also, the basal segment of the ovipositor is much more elongate, equal in length to segments three-six; rather than having apices of veins $R_4 + 5$ and $M_1 + 2$ marked with brown, wing markings as in figure 37a, and basal segment of ovipositor about equal in length to abdominal segments four to six as in *pantosticta*.

Front rufous, tinged with brown. Orbits, lunula, and area surrounding

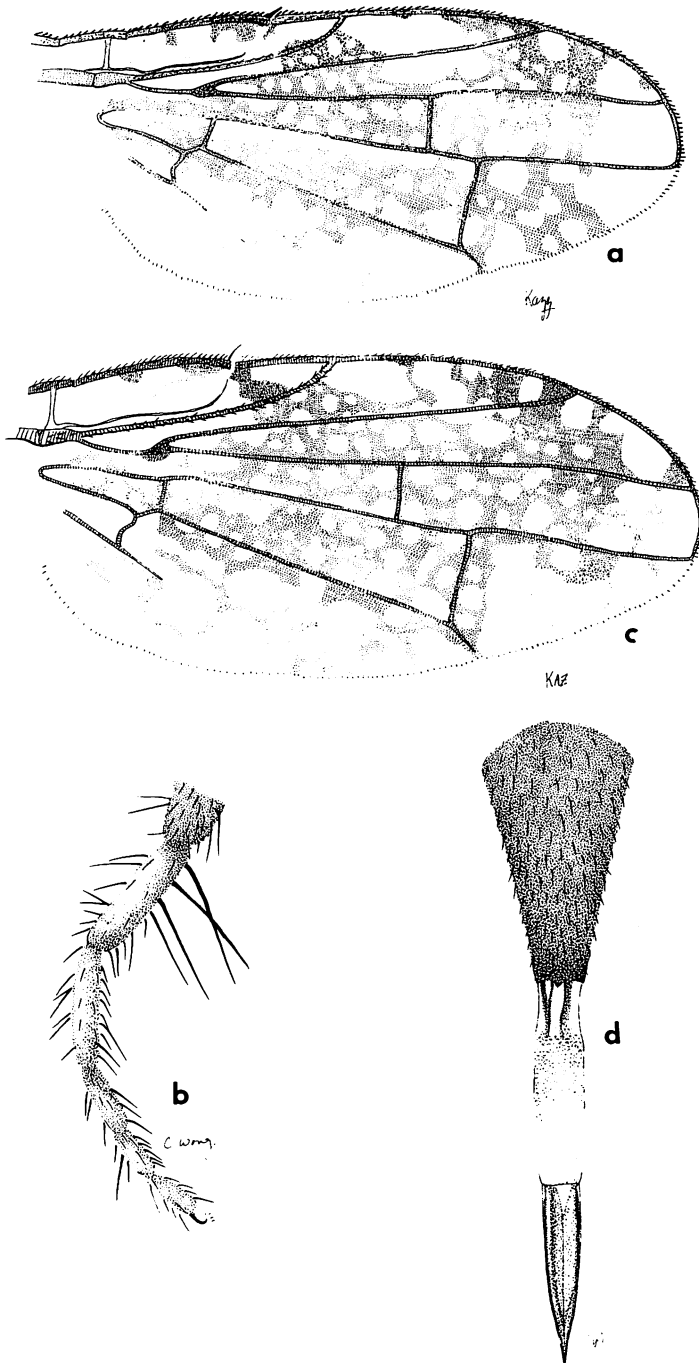


Figure 32—*Trupanea limpidapex* (Grimshaw): a, wing of male; b, front tarsus of male; c, wing of female; d, female ovipositor.

ocellar triangle, gray pollinose; in the original description Grimshaw stated that the front is dark purplish brown. Antennae yellow to rufous, tinged lightly with brown. Palpi and mouthparts yellow. Mesonotum gray pollinose, covered with white, scale-like hairs and with faint indications of three dull gray-black vittae down mesonotum. Upper superior fronto-orbital bristles brown to black in male, yellow-white in female. Legs yellow, tinged lightly with brown on femora. Front basitarsus about one-fifth as long as tibia and with long ventral hairs; the basitarsus is approximately equal in length to second tarsomere (fig. 32b). A prominent anterodorsal hair is present at or near apex of each of first four tarsomeres. The dorsal surface of front tibia is thickly covered with erect black setae. Wings distinctively marked (figs. 32a, c), rather similar in both sexes. Characterized by having apex and subcostal cell largely hyaline. Abdomen gray pollinose, covered with yellow-gray scales. In male the fifth sternum is about two times wider than long. The male cerci are prominent *in situ* extending well beyond margins of epandrium. The basal segment of female ovipositor is shining black, approximately equal in length to abdominal segments three-six and 2.35 mm. long, measured on the venter; the basal one-third to two-fifths is covered with yellow-white hairs, the apical portion with brown to black hairs. Sterna of female three or more times wider than long. Piercer tapers to a long pointed apex and is 1.64 mm. long. The extended ovipositor (fig. 32d) measures 5.7 mm. Spermathecae are elongate, spinose.

Length: Male, body and wings, 4.3 mm. Female, body, excluding ovipositor, 4.3 mm.; wings, 5.0 mm.

***Trupanea lipochaetae* Hardy, new species (figs. 33a-e)**

Because of the characteristics of the front tarsi, this species shows relationship to *T. crassipes* (Thomson), but differs by having the front basitarsus of the male scarcely over one-fourth as long as tibia and by the very different wing markings in both sexes (figs. 26a, 33a). In the key it runs near *megaspila* n. sp., from Hawaii, but the wing markings are much different as shown in figures 33a, 35a. Also, the front basitarsus of the male is developed very differently in these two species (figs. 33c, 35b), and the upper superior fronto-orbital bristles are yellow-white in *lipochaetae* and black in *megaspila*.

MALE. *Head:* Similar in most respects to other species of *Trupanea*, with three pairs of inferior fronto-orbital bristles and two pairs of superior fronto-orbitals, with the upper superior fronto-orbitals flat, scale-like. Front yellow to rufous in ground color, rather densely gray pollinose. Antennae, palpi, and mouthparts yellow. *Thorax:* Black in ground color except for yellow-brown humeri, densely gray pollinose. The pile of entire thorax is made up of yellow-white scales. Only two black bristles are present on each pleuron: one on upper hind margin of mesopleuron and one near upper edge of sternopleuron. The bristles of pteropleuron are yellow-white, flattened. *Legs:* Entirely yellow, black setose, with interspersed white dorsal and posterodorsal setae (or small

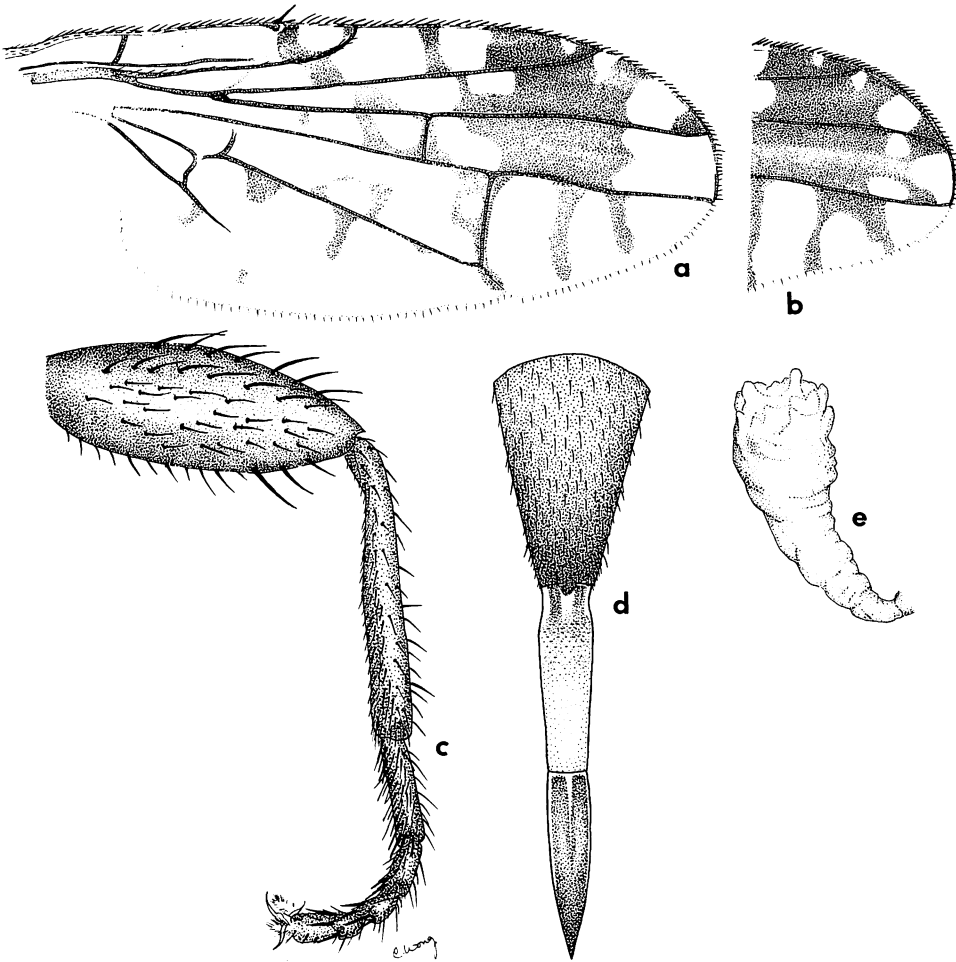


Figure 33—*Trupanea lipochaetae* Hardy, n. sp.: a, wing of male; b, apex of female wing; c, front leg of male; d, female ovipositor; e, female spermatheca.

bristles) on each front femur. Front tibia with short erect setae over dorsal surface. Front basitarsus slightly over one-fourth as long as the tibia, about two times longer than second tarsomere (fig. 33c) and with dense, short, yellow pile ventrally. *Wings*: First costal cell hyaline, except for a small brown median spot on costal margin. Subcostal cell brown at base and hyaline at apex. Three hyaline spots present in cell R_1 . A small hyaline spot in upper apex of cell R_3 just beyond apex of vein $R_2 + 3$, and a subapical hyaline spot in cell R_3 is confluent with the large hyaline spot, which extends through apices of cells R_5 and 2nd M_2 . Other wing markings as in figure 33a. *Abdomen*: Brown to black in ground color, covered with gray pollen and yellow-white pile. Fifth sternum only slightly wider than long.

Length; body and wings, 3.5 mm.

FEMALE. Fitting description of the male except for sexual characters. Front basitarsus is approximately one-half as long as the tibia and the wing markings differ slightly as shown in figure 33b. The ovipositor base is shining brown, the basal two-thirds of the seventh segment is thickly covered with yellow-white scales, the apical portion is covered with brown to black setae. The basal segment is almost equal in length to terga four to six and measures 1.2 mm. long on the venter. Piercer evenly tapered to apex (fig. 33d), 1.0 mm. long. Extended ovipositor measures 3.0 mm. Spermathecae as in figure 33e.

Length: body, excluding ovipositor, 3.6 mm.; wings, 3.4 mm.

Holotype male, allotype female, and fourteen paratypes (4 males and 10 females) from Waimanalo, Oahu, April 16, 1933, ex *Lipochaeta* (O. H. Swezey).

Type, allotype, and some of the paratypes in the B. P. Bishop Museum. The remainder of the paratypes are in the collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

***Trupanea marginalis* Hardy, new species (figs. 34a-b)**

Fitting in the complex which is characterized by having wings almost entirely dark brown, near *nigripennis*, and apparently differing only by wing markings. It is separated by the presence of a large, elongate, white spot in basal portion of fourth costal section, extending from apex of vein R_1 over one-third the length of cell R_1 along costal margin; also by having a round, white spot situated just beyond middle of fourth costal section and four to eight white spots in field of wing (fig. 34a). The type has two spots in cell R_5 , one well before r-m and one just beyond r-m crossvein and two spots in cell 1st M_2 , one at base and one at apex. The paratype has two small spots in basal portion of

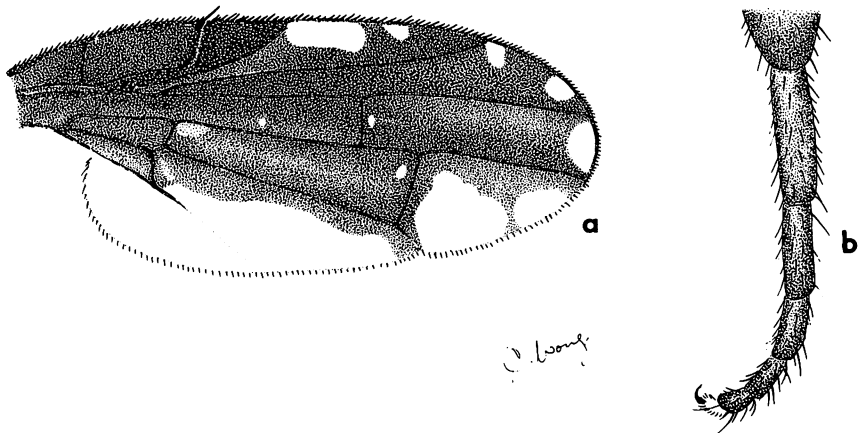


Figure 34—*Trupanea marginalis* Hardy, n. sp.: a, wing; b, front tarsus of male.

cell R_3 , three small spots in basal portion of R_5 ; this arrangement is obviously variable. I see no other characters for differentiating this species; in other regards it fits the description of *nigripennis*. Front tarsum of male as in figure 34b.

Holotype male, Kilauea Iki, Hawaii, 3800 ft., July 23, 1966 (J. W. Beardsley). One male paratype, Kilauea, Hawaii, twin craters; no date given (O. H. Swezey).

Type in B. P. Bishop Museum; paratype in University of Hawaii collection.

***Trupanea megaspila* Hardy, new species (figs. 35a-b)**

This species fits in the complex which is characterized by having the body pile pale, the wings with large brown preapical spots, the front basitarsi of male shortened, and the apices of cells R_5 and 2nd M_2 hyaline. It fits near *T. lipochaetae* n. sp., from Oahu, but differs by having the subcostal cells brown to black or with not more than a tiny hyaline spot in the upper apex; by having only one or two large hyaline spots present in cell R_1 ; cell M_4 with several dark markings reaching wing margin (fig. 35a); and by having the front basitarsus shorter than second tarsomere and bearing long ventral hairs. The male has

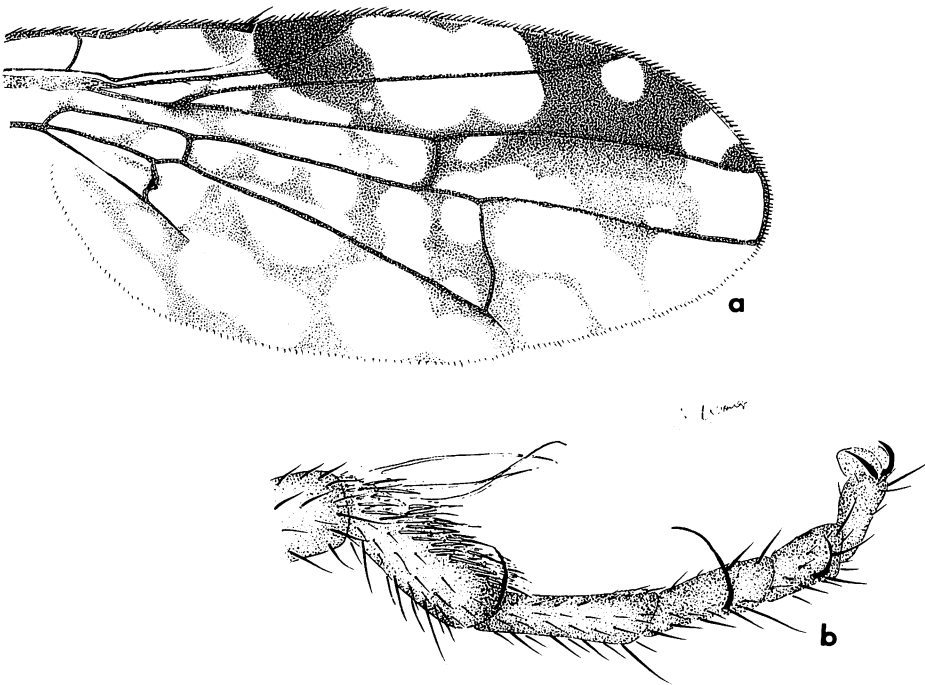


Figure 35—*Trupanea megaspila* Hardy, n. sp.: a, wing; b, front tarsus of male.

the cerci very prominently developed, elongate, readily seen *in situ* much as in *T. pantosticta* n. sp.

MALE. *Head:* Front rufous, tinged faintly with brown, eye orbits, ocellar triangle, and a narrow line down middle of front, as well as the lunula, gray pollinose. Upper fronto-orbital bristles typically black (on three of the four specimens at hand). Antennae, palpi, and mouthparts yellow to rufous. *Thorax:* Gray pollinose with faint indications of three subshining black vittae extending down mesonotum. Mesonotum completely covered with yellow-white, scale-like hairs. Halteres yellow. *Legs:* Yellow, tinged with brown on coxae. Front basitarsus approximately equal in length to the second tarsomere, and scarcely one-sixth as long as tibia, bearing long ventral hairs (fig. 35b). The front tibia has numerous erect dorsal setae. *Wings:* Subcostal cell all black or dark brown, sometimes with a small hyaline spot at upper apex. A large hyaline mark is present just beyond apex of subcostal vein extending through a large portion of cell R_1 and into upper two-thirds of cell R_3 . Apex of wing entirely hyaline, except for a small dark brown to black spot just above tip of vein $R_4 + 5$; this hyaline marking extends basad to cell 2nd M_2 , almost to m crossvein (fig. 35a). Cells R , R_5 , and 1st M_2 are rather sparsely spotted. *Abdomen:* Dull gray pollinose, densely covered with yellow-white scales. The cerci are prominent, equal or longer than epandrium and bearing moderately long setae at apex. The genitalia have not been dissected for study.

Length: body, 2.85 mm.; wings, 3.2 mm.

FEMALE. Unknown.

Holotype male and three male paratypes from Pohakuloa, Hawaii, 6500 ft., January 29, 1963, collected on *Dubautia* sp.? (D. E. Hardy).

Type in the B. P. Bishop Museum. Paratypes in the collections of the U.S. National Museum and the University of Hawaii.

***Trupanea nigripennis* Hardy, new species (figs. 36a-d)**

Fitting close to *celaenoptera* n. sp. but differing by having the femora brown to black; the humeri black in ground color; the abdomen mostly black setose; the front basitarsus more slender, about one-third as long as tibia, two times longer than second tarsomere and with few short, erect setae ventrally. Wing markings distinctly different, with wing mostly dark brown with prominent white spots in apices of cells R_3 , R_5 , and 2nd M_2 , and with posterior margin of wing rather broadly white; also, the front femora have strong black setae over dorsal surfaces rather than white. Head and body bristles entirely black, except for white upper superior fronto-orbitals, postocellars, outer verticals, and the occipital row. Genae rather densely covered with erect black setae and genal bristle moderately well developed, two times longer than the longest setae. Third antennal segment scarcely one-half longer than wide, straight on dorsal surface, broadly rounded below, and arista short pubescent (fig. 36a). Front rather densely gray pollinose, face silvery-gray. Front tarsi as in figure 36c, and wings as in figure 36b. Wing markings shows some variability; the

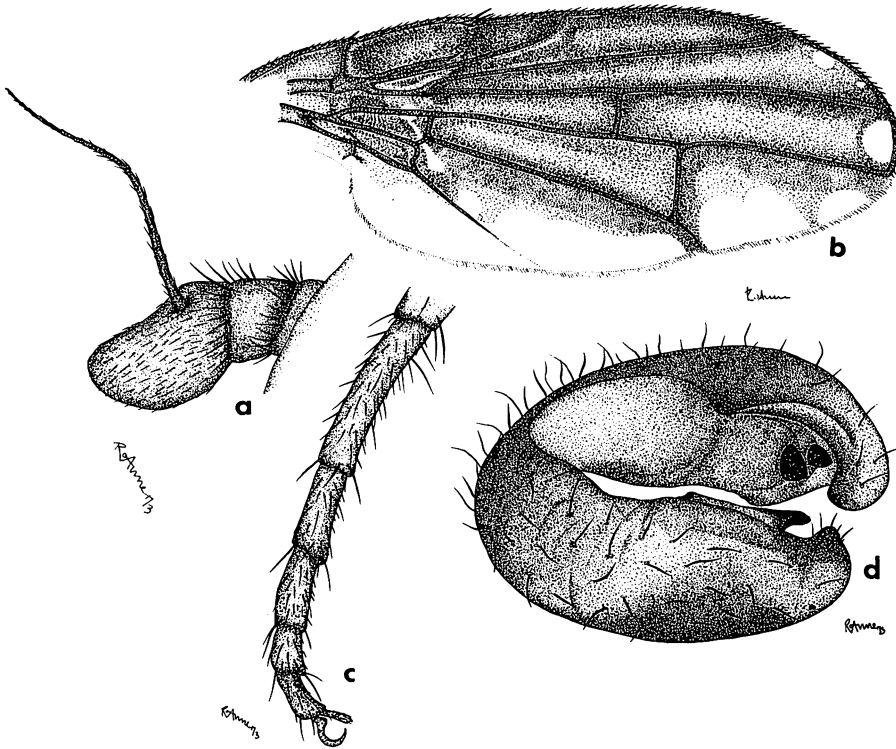


Figure 36—*Trupanea nigripennis* Hardy, n. sp.: a, antenna; b, wing; c, front tarsus of male; d, male genitalia.

size of the white spots in apex of cell R_3 varies. First two abdominal segments with short white setae over median portion; otherwise, the abdomen is black setose and all bristles are black. Setae over dorsum of thorax vary from yellow-white to pale brownish yellow. The genitalia differ from *celaenoptera* by lacking a prominent protruberance at dorsoapical portion of surstyli, and the black lobes at apex of tenth sternum are different in shape (fig. 36d).

Length: body, 4.0 mm.; wings, 4.5 mm.

FEMALE. Unknown.

Holotype male and one male paratype from Hualalai, Kona side, Kahaluu Forest, Hawaii, July 23, 1966 (J. W. Beardsley).

Type in the B. P. Bishop Museum; paratype in University of Hawaii collection.

***Trupanea pantosticta* Hardy, new species (figs. 37a-b)**

This species fits in the group which is characterized by having the setae on mesonotum and abdomen entirely yellow-white, scale-like; and by having the wings densely covered with small hyaline spots, and lacking a large brown

preapical spot. It is differentiated from other species in this group by having the apices of veins $R_4 + 5$ and $M_1 + 2$ marked with brown; by having a brown mark on costa opposite end of subcostal vein; the wing markings as in figure 37a, and the male cerci elongate, three to four times longer than wide.

MALE. Head: As seen in direct lateral view the head is approximately as high as long. Front rufous, tinged faintly with brown on upper portion. Orbits, ocellar triangle, and lunula gray pollinose. Upper superior fronto-orbital bristles yellow-brown; other frontal bristles black. Antennae rufous, palpi yellow. **Thorax:** Entirely gray pollinose, lacking vittae on mesonotum. Humeri yellow, halteres yellow, tinged with brown on knobs. **Legs:** Entirely yellow, except for a tinge of brown on mid and hind coxae. Front basitarsus short and thickened, bearing long ventral hairs. Basitarsus one-third to one-half longer than second tarsomere, but scarcely more than one-fifth as long as tibia. Front tibia with numerous erect dorsal setae. **Wing:** Almost completely covered with abundant small hyaline spots (fig. 37a). Subcostal cell with a large hyaline spot in apical portion. Cell R_1 with three hyaline spots along costa and numerous small spots just above vein $R_3 + 4$. Cell R_5 has a moderately large hyaline spot filling apex, bordered by a brown mark which extends over apices of veins $R_4 + 5$ and $M_1 + 2$. **Abdomen:** Entirely gray pollinose, and covered with yellow-

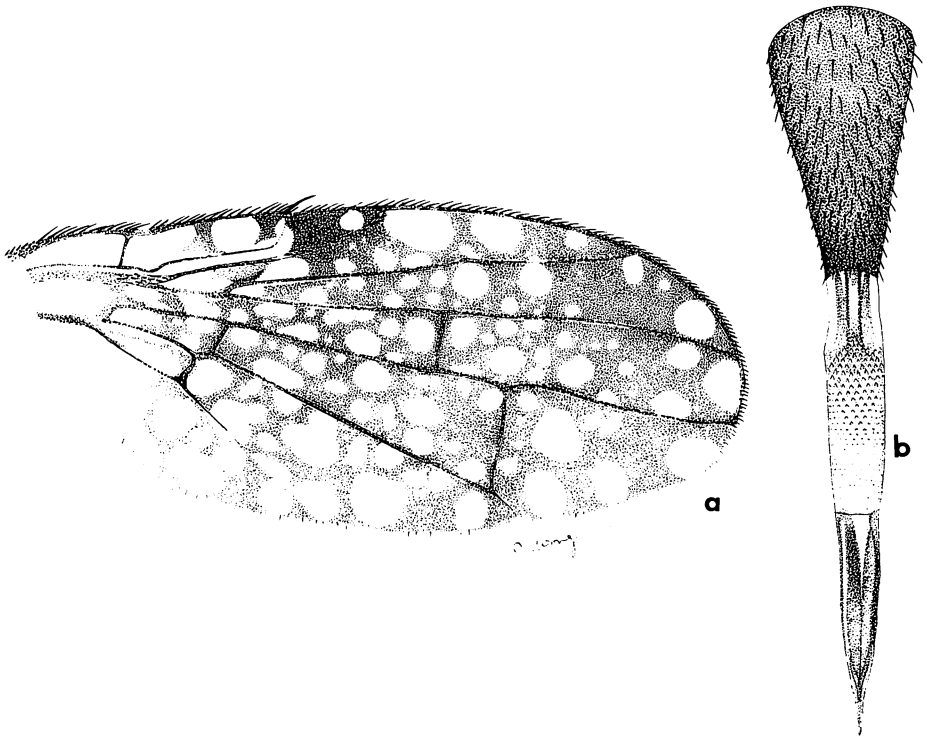


Figure 37—*Trupanea pantosticta* Hardy, n. sp.: a, wing; b, female ovipositor.

white scale-like hairs, except for black bristle-like hairs along lateral margins of terga. Fifth sternum over two times wider than long. Cerci very prominently developed, almost as long as epandrium and densely yellow-haired.

Length: body, 3.2 mm.; wings, 3.6 mm.

FEMALE. Similar to male except for sexual characters. Front basitarsi not shortened. Wing markings rather similar in both sexes. Base of ovipositor shining black, with yellow-white, flattened hairs on the basal two-fifths of segment and brown to black hairs on apical portion. Basal segment approximately equal to abdominal segments four-six. Extended ovipositor measures approximately 3.9 mm. in length. The base measures approximately 1.4 mm. and the piercer and inversion membrane each measure approximately 1.25 mm. Piercer sharply pointed, shaped as in figure 37b.

Length: body, not counting segment seven or ovipositor, 4.3 mm.; wings, 4.6 mm.

Holotype male, Kilauea, Hawaii, Makaopuhi, June 28, 1934, ex *Railliardia* (= *Dubautia*) (O. H. Swezey). Allotype female, same locality as type, October 14, 1929 (R. R. Whitten). Thirteen paratypes (six males, seven females), same locality as type and allotype, some same data as type and allotype, May, 1912–April, 1920 (O. H. Swezey and D. T. Fullaway); and one, April 22, 1920 (O. H. Swezey); Kilauea Iki, Kilauea, Hawaii, April, 1906 and July, 1966 (O. H. Swezey and J. W. Beardsley); Aloi Crater, Hawaii, 3000 ft., June, 1966 (J. W. Beardsley), and Saddle Road, Hawaii, 5200 ft., August, 1973 (K. Y. Kaneshiro).

Type and allotype in the B. P. Bishop Museum. Paratypes in the collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

***Trupanea pekelo* Hardy, new species (figs. 38a–e)**

This species fits near *T. limpidapex* (Grimshaw), from Maui, but is differentiated by having the subcostal cell almost entirely brown, and by having cells 1st M₂, R, and R₅, sparsely spotted (fig. 38a), with about five to eight spots in each.

MALE. *Head:* Similar to most other Hawaiian *Trupanea*, except the upper superior fronto-orbital bristles are black. *Thorax:* Black in ground color except for yellow humeri covered with gray pollen on mesonotum, with no indication of brown vittae, and yellow-gray pollinose on pleura. The pile of entire thorax is yellow-white. *Legs:* Yellow, except for a tinge of brown on mid and hind coxae. Front basitarsi short, somewhat thickened, scarcely over one-fifth as long as tibia and equal to or slightly longer than the second tarsomere (fig. 38d), and bearing several long, ventral, yellow hairs. An apical or preapical anterodorsal brown to black hair is present on tarsomeres one to four. *Wings:* The subcostal cell is predominantly or entirely brown, typically having a small hyaline spot at upper apex. Cell R₁ has two large, hyaline spots which extend transversely through upper two-thirds to three-fourths of cell R₃. Entire apex

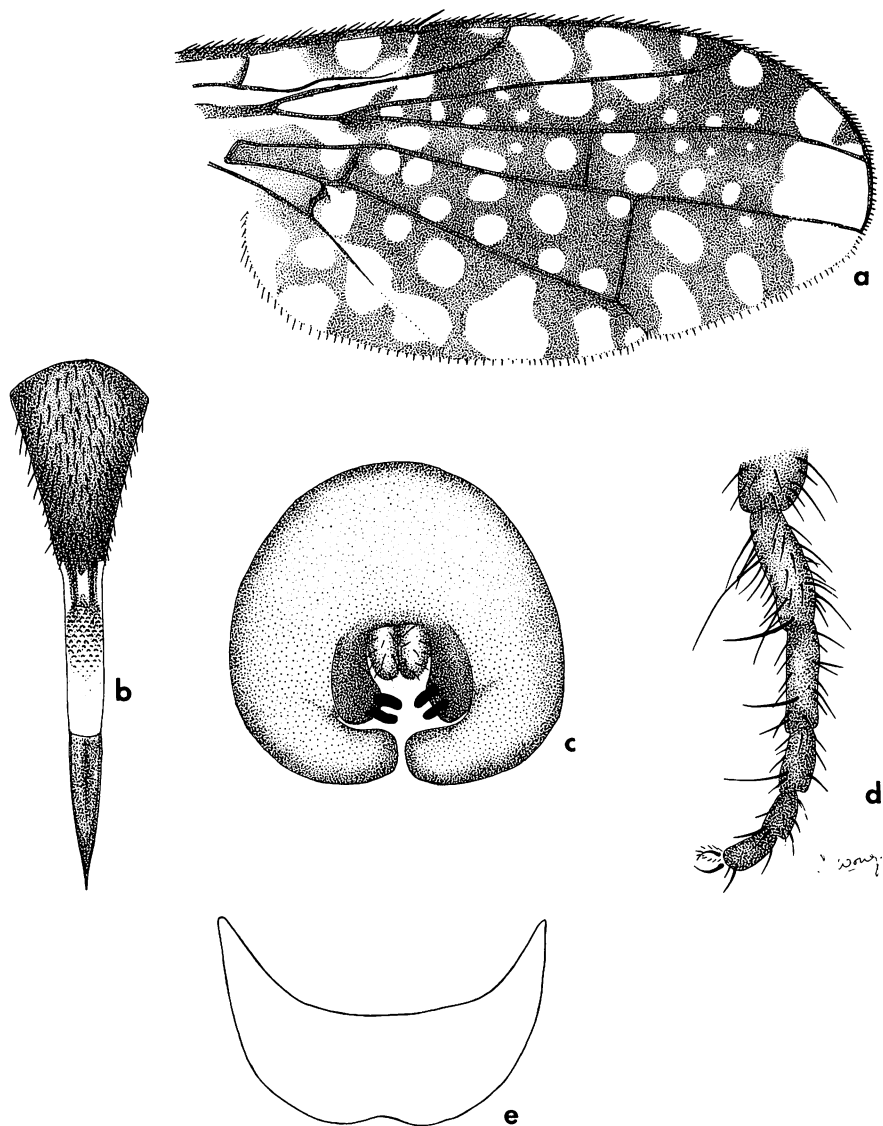


Figure 38—*Trupanea pekeloï* Hardy, n. sp.: a, wing; b, female ovipositor; c, male genitalia; d, front tarsus of male; e, fifth sternum of male.

of wing hyaline except for a small brown spot immediately above tip of vein $R_4 + 5$. Other details of wing venation and markings as in figure 38a. *Abdomen*: Entirely black, covered with yellow-gray pollen and yellow-white pile. Fifth sternum over two times wider than long and concave on posterior margin (fig. 38e). Cerci about as high as long. Genitalia as in figure 38c.

FEMALE. Similar to male except that upper superior fronto-orbitals are

yellow and the wings show slight differences in arrangement of the hyaline spots. Basal segment of ovipositor polished black, yellow-white setose on basal two-thirds, black setose on apex; equal in length to terga 4-6 and 1.5 mm. long measured on the venter. Extended ovipositor 3.7 mm. long. Piercer tapered to a long point at apex (fig. 38b), 1.2 mm. long.

Length: body and wings, 3.5 mm.

Holotype male, Puu Kolehale, Molokai, March 23, 1929, collected on *Dubautia* sp. (O. H. Swezey). Allotype female, Kamoku, Molokai, July 18, 1963 (D. E. Hardy). Eight paratypes (= seven males and one female) all same data as type and allotype, except one specimen taken above Waikolu Valley, 1400 m., April 28, 1955 (E. J. Ford, Jr.).

Type and one paratype in the B. P. Bishop Museum, the remainder in collections of U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

This species is named after Noah K. Pekelo, Jr., supervising conservation officer, Honolulu, Oahu, who has made many valuable contributions to the knowledge of the natural history of the island of Molokai, and who has served as a guide and colleague on numerous trips into the interior collecting endemic flies.

***Trupanea perkinsi* Hardy, new species (figs. 39a-b)**

This species fits very close to *T. lipochaetae*, from Oahu, but the wing markings are quite strikingly different. *T. perkinsi* is differentiated by having the basal half of wing largely brown, with round hyaline spots and by having the brown markings extended to wing margin through cell M_4 (fig. 39a). In *lipochaetae* the basal half of wing, including the posterior margin behind apex of vein $M_3 + 4$, is hyaline, sparsely streaked with brown, and lacking round hyaline spots (fig. 33a).

MALE and FEMALE. Fitting description of *lipochaetae* in most regards but with very distinctive wing markings as pointed out above and as shown in figures 33a, 39a. In the female the yellow-white pile extends only over about the basal one-third of ovipositor base; in *lipochaetae* the yellow-white pile extends over two-thirds of ovipositor base. Ovipositor as in figure 39b.

Length: Male, body and wings, 3.6 mm. Female, body, excluding ovipositor, 3.2 mm.; wings, 3.75 mm.

Holotype male, Kokee, Kauai, 3600 ft., July, 1952, (D. E. Hardy). Allotype female, same locality as type, August, 1955 (J. W. Beardsley). Four paratypes (three females, one male): two same data as allotype, one labeled "ex *Euphorbia*," one specimen labeled Kauai, 2-3000 ft., January and February, 1897 (R. C. L. Perkins).

Type, allotype, and one paratype in the B. P. Bishop Museum. The remainder of the paratypes in the collections of the U.S. National Museum and the University of Hawaii.

It is a pleasure to name this species after Dr. R. C. L. Perkins, who did the

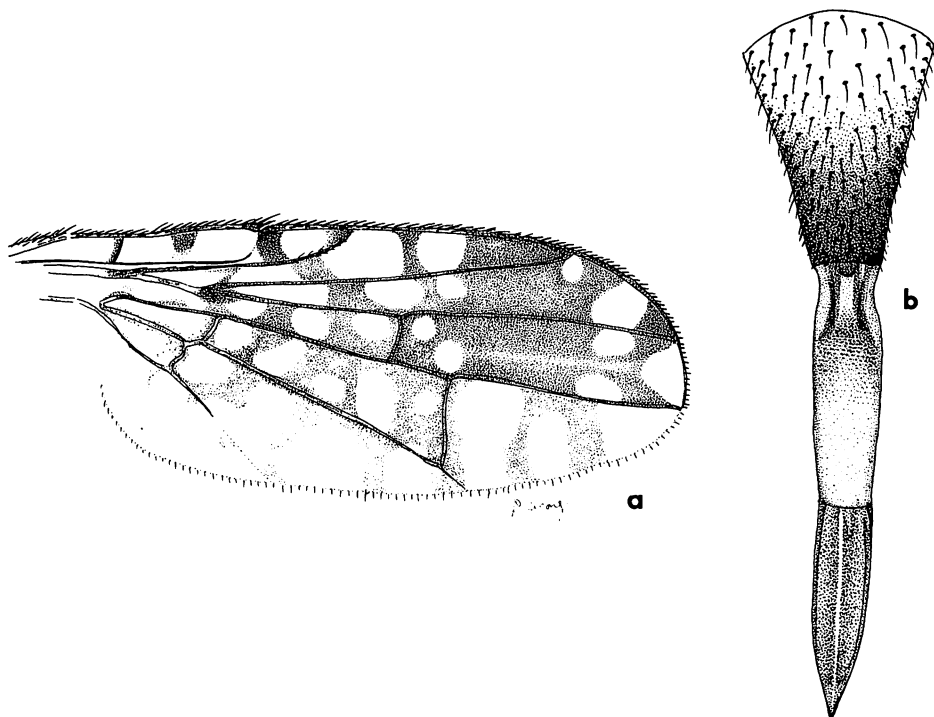


Figure 39—*Trupanea perkinsi* Hardy, n. sp.: a, wing; b, female ovipositor.

monumental field work which resulted in the Fauna Hawaiiensis. One of the specimens in the type series is from the Perkins collection.

***Trupanea swezeyi* (Bryan) (figs. 40a-c)**

Tephritis swezeyi Bryan, 1921, Proc. Haw. Ent. Soc. 4:478.

Endemic. Oahu (type-locality: Palolo), Maui and Kauai. The latter two are new island records.

Host. Infests flowerheads of *Dubautia*.

This species is characterized by having the mesonotum yellow-white pilose and the abdomen mostly black pilose. It fits near *T. arboreae* n. sp., from Hawaii, but differs by having the legs yellow, tinged lightly with brown on femora, rather than having the femora dark brown to black; by having the front basitarsus of male about one-third as long as tibia and with rather short ventral hairs (fig. 40c), rather than being about one-fifth as long as tibia and with long ventral hairs; also by the very different wing markings as shown in figures 22a, 40a.

The front is mostly brownish yellow to rufous. The eye orbits, lunula, and area surrounding ocellar triangle are gray pollinose; also, a lightly gray

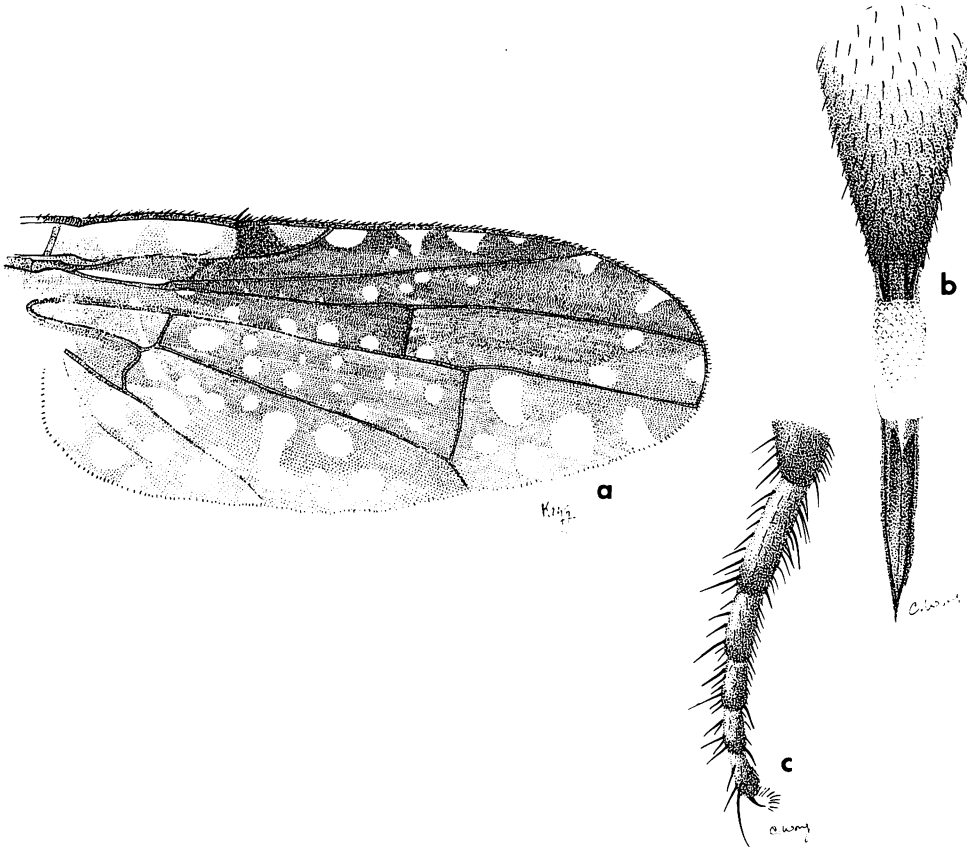


Figure 40—*Trupanea swezeyi* (Bryan): a, wing; b, female ovipositor; c, front tarsus of male.

pollinose area extends almost entire length through median portion of front. The occiput is yellow except for black upper median portion. The first two antennal segments are yellow; the third segment is dark brown. The palpi and mouthparts are yellow. The thorax is predominantly gray pollinose, a brown pollinose marking extends over posterior median portion of mesonotum and continues as three narrow vittae over anterior portion of mesonotum. The disc of scutellum is pale brown pollinose. The mesonotum is completely covered with yellow-white, scale-like hairs. The legs are entirely yellow. The front basitarsus is about one-third as long as tibia, the ventral hairs are rather short (fig. 40c). Numerous erect dorsal setae extend the entire length of front tibia. Wings predominantly brown, abundantly covered with small, round, hyaline spots as in figure 40a. The wings show considerable variation in arrangement of the hyaline spots. The first two abdominal terga are predominantly pale pilose, terga three-five of the male and three-six of the female with a line of yellow-white setae along base and scattered yellow-white setae on margins,

otherwise brown to black setose. The fifth and sixth sterna of male are distinctly wider than long. The extended ovipositor of the female is longer than the remainder of the body. The total length is 5.58 mm. The piercer measures 1.9 mm.; the inversion membrane is 1.58 mm.; and the base (segment seven) 2.1 mm. The piercer is slender (fig. 40b).

Length: Male, body and wings, 5.35 mm. Female, body, not including ovipositor, 5.0 mm.; wings, 5.85 mm.

It is possible that the populations from Oahu, Maui, and Kauai may represent three distinct species, but we are unable to find distinctive features at present.

Subfamily TRYPETINAE

Tribe CERATITINI

Genus **CERATITIS** Macleay

Ceratitis Macleay, 1829, Zool. J. Lond. 4:482. Type-species, *citriperda* Macleay, by monotypy, = *capitata* (Wiedemann).

For synonymy refer to Hendel (1927:158).

The convex, rounded scutellum, which is characteristic of Ceratitini, and the distinctive wing (fig. 41e) and thoracic markings (fig. 41d) will differentiate this genus from other Tephritidae in Hawaii or the Pacific. The tribe is African; it is apparently absent in the Pacific area and is poorly represented in the Australasian and Oriental regions.

Head higher than long, eye almost round, and face vertical, antennal furrows shallow. Two pairs inferior fronto-orbital and two pairs superior fronto-orbital bristles. Third antennal segment two times longer than wide and broadly rounded at apex. Genae broad, about $\frac{1}{4}$ eye height. Dorsocentral bristles situated opposite supraalar. Wings as in figure 41e.

Three African species are placed here.

Ceratitis capitata (Wiedemann) (figs. 41a-e)

Trypeta capitata Wiedemann, 1824, Analecta Ent.:55. Type-locality: East India.

Widespread throughout the Hawaiian Islands, but since the introduction of the oriental fruit fly (1945), it has become rare or extinct in the lowlands and is now restricted to higher elevations (2000-6000 ft.). It is found mainly on the island of Hawaii, where it breeds largely in coffee berries and Jerusalem cherry (*Solanum pseudocapsicum* L.). Accidentally introduced into Hawaii about 1907, from Sydney, Australia, and first reported in June 1910 (Erhorn, 1910:336). For biology and importance in Hawaii, refer to Back and Pemberton (1918), Mason (1932), and Hardy (1949:186); and for parasites refer to Silvestri (1914) and Willard (1927).

Immigrant. An African species widespread over much of the world:

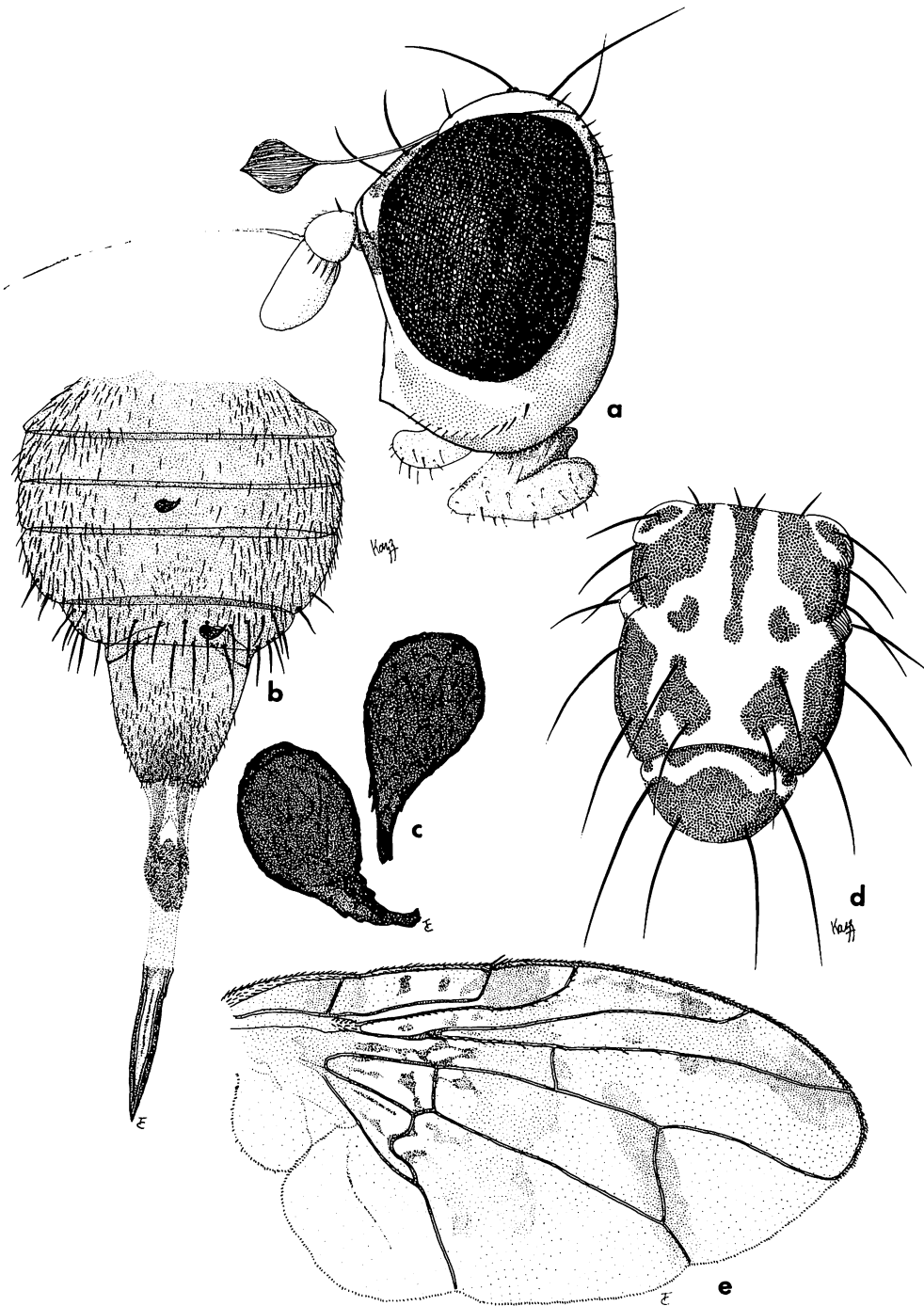


Figure 41—*Ceratitis capitata* (Wiedemann): a, head of male; b, female abdomen; c, spermathecae; d, thorax, dorsal view; e, wing.

Mediterranean region, Neotropical region, Florida (infrequent invasions from Central America), Canary Islands, Madagascar, Mauritius, Zanzibar, Australia, Hawaii.

Hosts: A very destructive species; one of the most notorious fruit flies in the world. Infests a very wide range of fleshy fruits: orange and other citrus fruit, peach, pear, apricot, banana, coffee, papaya, mango, guava, cherry, etc. Attacking approximately the same host fruits as the oriental fruit fly (*Dacus dorsalis*).

Readily differentiated by the wing markings (fig. 41e), thoracic pattern (fig. 41d), and by the peculiar capitate lower superior fronto-orbital bristles of the male (fig. 41a).

Yellow species except for the predominantly polished black mesonotum, scutellum, and postscutellum. Thorax yellow pilose except for black pile on mesopleura of male. Head as in figure 41a. Scutellum with an irregular band of yellow across base. Mesonotum yellow on posteromedian margin, yellow on suture and notopleural calli, humeri also yellow except for a polished brown to black spot at base of bristle. Mesonotum with densely pollinose pattern as in figure 41d. Wing venation and markings as in figure 41e. Abdomen yellow, apices of second and fourth terga gray pollinose. Fifth sternum of male two times longer than wide, hind margin almost straight. Sixth tergum of female much shorter than fifth. Abdomen of female as in figure 41b. Two heavily sclerotized pear-shaped spermathecae (fig. 41c).

Length: body and wings, 4.4–4.7 mm.

Family SEPSIDAE

Moderately small, dung frequenting flies readily recognized by their ant-like appearance, usually with a large brown to black spot on margin before apex of wing and by their wing waving habit. Metallic black flies often with a greenish coppery or violet sheen. Head almost spherical. Palpi vestigial. Antennae short, third segment oval. Hawaiian species with only one pair of strong ocellar and one pair of divergent postocellars. Metathoracic spiracle (just below halter) with one long bristle-like hair in addition to short pubescence. Front legs of male highly ornate (fig. 43c). Wings with costa unbroken, vein Sc complete and well separated from R_1 (fig. 42c).

Genus SEPSIS Fallén

Sepsis Fallén, 1810, Spec. Ent. nov. Dipt.:17. Type-species, *Musca cynipsea* Linnaeus, by subsequent designation (Curtis, 1829: pl. 245).

Sepsidimorpha Frey, 1908, Dt. Ent. Z. 1908:584. Type-species, *Sepsis loewi* Hendel, by monotypy, = syn. of *pilipes* van der Wulp.

For other synonyms refer to Hennig (1949:621).

This genus is differentiated by having the basal cells separated; mesopleural, humeral, and outer vertical bristles present and fronto-orbital

bristles very weak or absent; front femora of male highly ornate (fig. 42b), and wing usually with a brown preapical spot on margin at apex of vein $R_2 + 3$ (fig. 42c).

These flies are predominantly breeders in fresh animal dung and in Hawaii, are found wherever there are horses or cattle; also a third species now appears to be associated with dog feces.

The *Sepsis* have been largely neglected since the monographs of Melander and Spuler (1917), Duda (1926), and Hennig (1949).

Three species are known from Hawaii; these show a rather wide range of variation in coloration and size. They are differentiated by the following characters:

1. Wings with a prominent preapical black spot (figs. 42c, 43d). 2
Wings lacking the preapical spot. Front legs and genitalia of males as in figures 42f, g.
. **lateralis** Wiedemann.
2. Sternopleura entirely densely gray pruinose. A pair of weak orbital bristles present near middle of front (fig. 42a), hind tibia with an anteroventral bristle near apical two-thirds and wing spot comparatively large (fig. 42c). Male genitalia as in figure 42d. **biflexuosa** Strobl.
Lower two-thirds of each sternopleuron polished, silvery gray pruinose along upper margin and more lightly so along anterior margin. No orbital bristles on front or anteroventral bristles on hind tibia, and wing spot comparatively small (fig. 43d). Male genitalia as in figure 43b.
. **thoracica** (Robineau-Desvoidy).

***Sepsis biflexuosa* Strobl (figs. 42a-e)**

Sepsis biflexuosa Strobl, 1893, Wien. Ent. Ztg. 12:225. Type-locality: Europe.

For synonymy under this species refer to Hennig (1949:76) and Steyskal, *in* Stone et al. (1965:683).

Oahu, Hawaii, Maui, Molokai, and Kauai.

Immigrant. Widespread over Europe, Canary Islands, North America, Canada, Mexico.

First recorded in Hawaii by Hardy (1953:7) from Oahu as "*S. biflexuosa*" and its variety *S. biflexuosa curvitibia* Melander and Spuler (the latter has been synonymized with *curvitibia*, ref. Steyskal, *loc. cit.*).

Immature stages. Refer to Hennig (1949, text figures 27, 36, 40, 59, 60, 61).

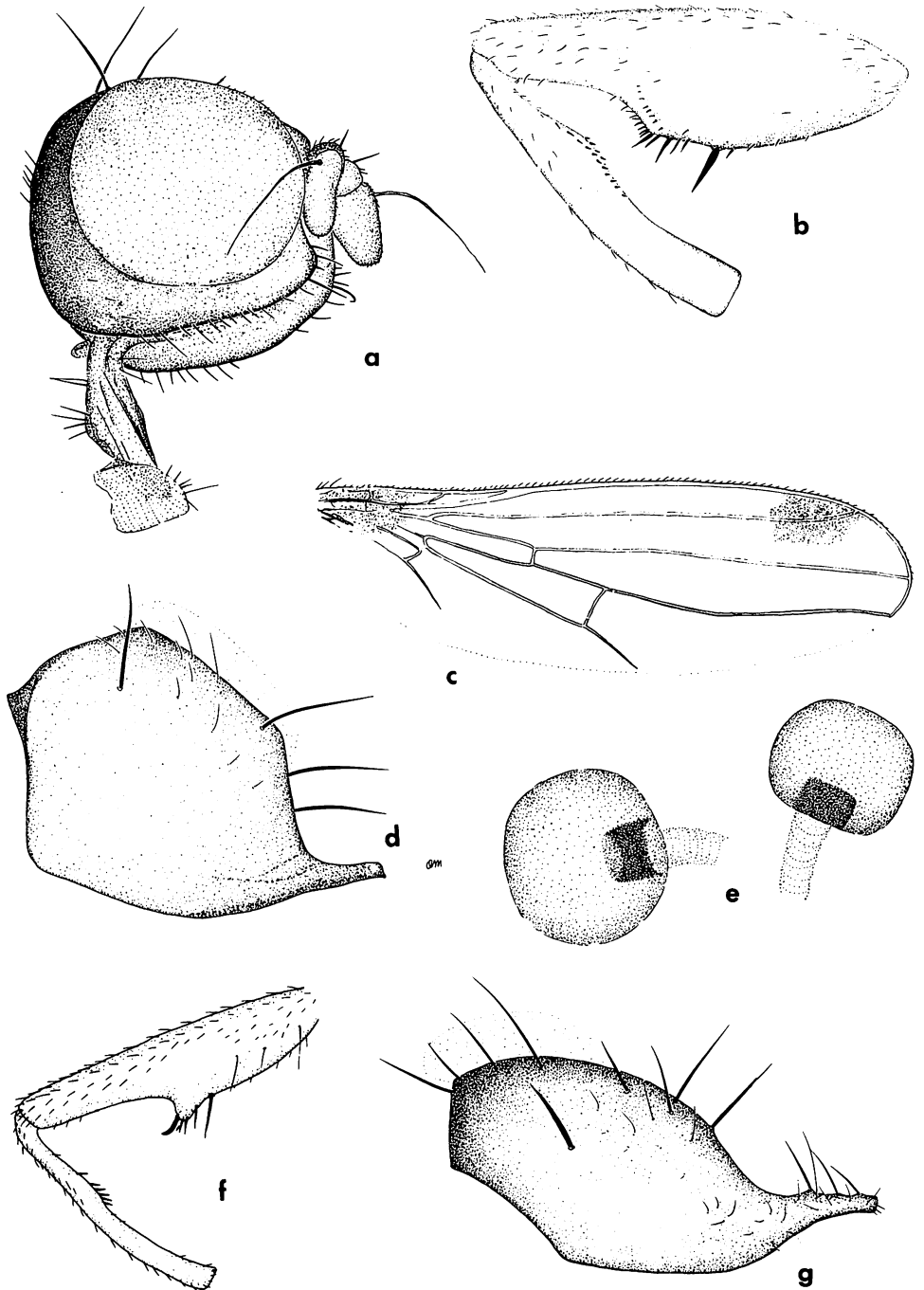


Figure 42—*Sepsis biflexuosa* Strobl: a, head; b, front leg of male; c, wing; d, male genitalia; e, spermathecae of female. *S. lateralis* Wiedemann: f, front leg of male; g, male genitalia.

Readily differentiated from other *Sepsis* by having the sternopleura densely gray pruinose, in combination with the presence of a small orbital bristle in middle of front, and front tibia of male sinuate. The ornamentation of the front femur as in figure 42b and the male surstylus straight-sided, obliquely pointed apically (fig. 42d). The legs show considerable variation in the color from those which are predominantly yellow to those which have the legs almost entirely black. Head shaped as in figure 42a. Front tibia with two irregular rows of short, black ventral spicules extending over basal third of segment and front femur strongly swollen on basal two-thirds with several ventral spines and numerous black setae over the tubercle (fig. 42b). Wings as in figure 42c with the apical spot typically longer than wide and the last section of vein $M_3 + 4$ about one-half longer than m crossvein. Male genitalia as in figure 42b with the epandrium broad, cerci narrow, and surstyli straight sided, rather short, obliquely pointed or nearly truncate apically. Hypandrium expanded and aedeagus complex. Female cerci short, as wide as long, each bearing two prominent setae. Egg guides slender, strap-like. Two large, round, spermathecae (fig. 42e).

***Sepsis lateralis* Wiedemann (figs. 42f-g)**

Sepsis lateralis Wiedemann, 1830, Aussereur. Zweifl. Ins. 2:468. Type-locality: "China."

For synonymy refer to Hennig (1949:65-66).

Oahu. First reported April 1973 (Hardy, 1974).

Immigrant. Widespread over Palaearctic, Ethiopian and Oriental Regions, and New Guinea (Ref. Hennig, 1949:66).

Habits: In Hawaii this species was first observed April 18, 1973, on the University of Hawaii campus, Honolulu, attracted to lower trunk and roots of a kukui nut tree (*Aleurites moluccana* [L.] Willd.), which had been killed by termites (Hardy, 1974). The trunk gave off a strange, rather foul odor which was obviously attractive to the flies. It has since been reared from and collected on dog feces from Palolo and Manoa Valleys, Oahu, and is probably widespread over this Island.

This species is readily differentiated from other sepsids in Hawaii by lacking a preapical spot in the wing as well as by the characteristics of the front legs of the male (fig. 42f) and the male genitalia (fig. 42g). In Hennig's key (1949:59) it fits near *mcquignoni* Séguy, from the Azores, but the ornamentation of the front legs is very different (compare text fig. 75, Hennig p. 67, with fig. 42a in this paper).

Similar to *thoracica* (Robineau-Desvoidy) except for the wing, front leg, and genitalic characters; also, the hind tibia has an anteroventral bristle near apical three-fifths, as in *biflexuosa* Strobl. The sternopleuron is polished, except for gray pruinose dorsal margin. The specimens are typically black, except for yellow, or rufous front legs, tarsi, coxae, trochanters, propleura, and lower

margin of head. A wide range of color variation occurs all the way to specimens which are entirely yellow to rufous except for black in median portion of mesonotum and fourth and fifth abdominal terga. Refer to figures 42f, g for characteristics of the male front legs and genitalia.

For a detailed description refer to Hennig (1949:65).

***Sepsis thoracica* Robineau-Desvoidy (figs. 43a-d)**

Micropeza thoracica Robineau-Desvoidy, 1830, Essai sur les Myodaires [Ser. 2], 2:742.

For synonymy refer to Hennig (1949:67).

Oahu, Maui, and Molokai. Only recently (March, 1973) discovered, associated with horse and cattle dung and appearing to have replaced *biflexuosa* on these three islands (Hardy, 1974).

Immigrant. Widespread over Palaearctic, Ethiopian, and Oriental regions.

Immature stages. Refer to Hennig (1949, figs. 26, 35, 38, 57, 58).

Readily differentiated from *biflexuosa* by having the sternopleuron polished on lower two-thirds, no fronto-orbital bristles; apical wing spot comparatively small (fig. 43d), and male surstylus curved downward at apex (fig. 43b).

Extremely variable in coloration. The males usually having the genae, pleura, and femora predominantly or entirely rufous and sides of basal section of abdomen tinged yellow. All degrees of variation are seen from this condition to those which are almost entirely black except for the brownish yellow to rufous front coxae. Dr. Jan Zuska, Praha, Czechoslovakia, *in litt.*, has indicated that *thoracica* usually occurs in the small dark form, "but occasionally (as in most species of *Sepsis* in warmer areas) larger reddish specimens are found." The front has a row of microscopic setae on lower two-thirds near orbits. Genae comparatively broad, distinctly wider than the third antennal segment. Oral vibrissae prominent. Two pairs of rather strong dorsocentral bristles and with two rows of rather prominent acrostichal setae, as well as a complete row of dorsocentral setae and with erect black setae on sides of mesonotum. Upper edge of sternopleuron silvery gray pruinose and anterior margin more lightly pruinose, otherwise polished. Front tibia with a row of stout black bristles on about basal third to two-fifths, terminating in a rather prominent apicoventral spur-like point and much less sinuate than in *biflexuosa*. Front femur as in figure 43c. Wings similar to that of *biflexuosa* except that the apical spot is quadrate, as long as wide, and the last section of vein $M_3 + 4$ is equal in length to the m crossvein. The surstyli are distinctive in shape (fig. 43b), curved downward at apices and with prominent teeth on inner edges. The hypandrium and aedeagus are very complex. The former terminates in a pair of leaf-like structures which have tiny setae on margins (fig. 43a).

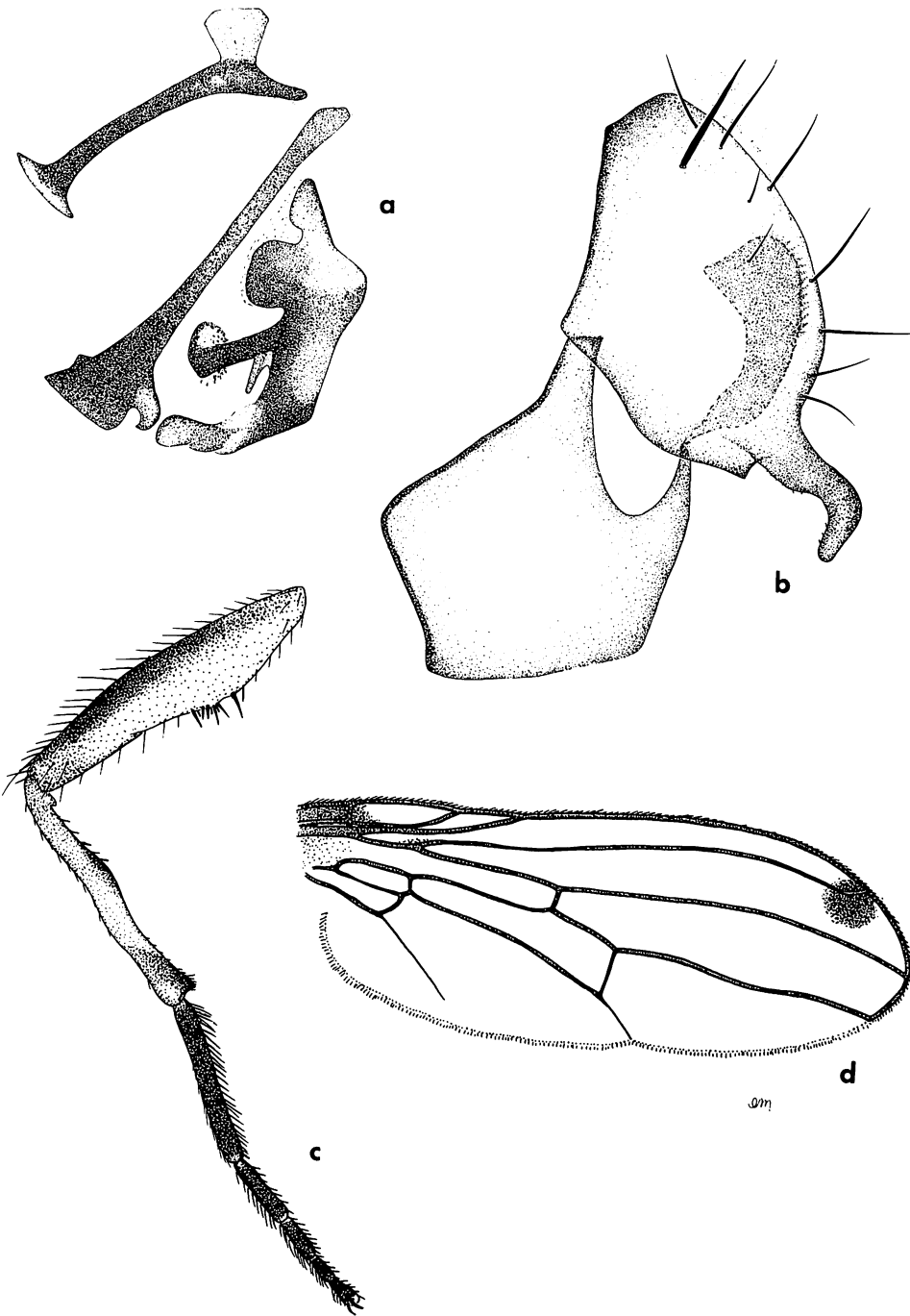


Figure 43—*Sepsis thoracica* Robineau-Desvoidy: a, aedeagus and ejaculatory apodeme of male; b, male genitalia, lateral (aedeagus removed); c, front leg, male; d, wing.

- Genus
- ATRICHOMELINA**
- Cresson

Purposely introduced from New York (probably laboratory colony) as a natural enemy of freshwater snails. Released on Oahu, Hawaii, and Kauai,

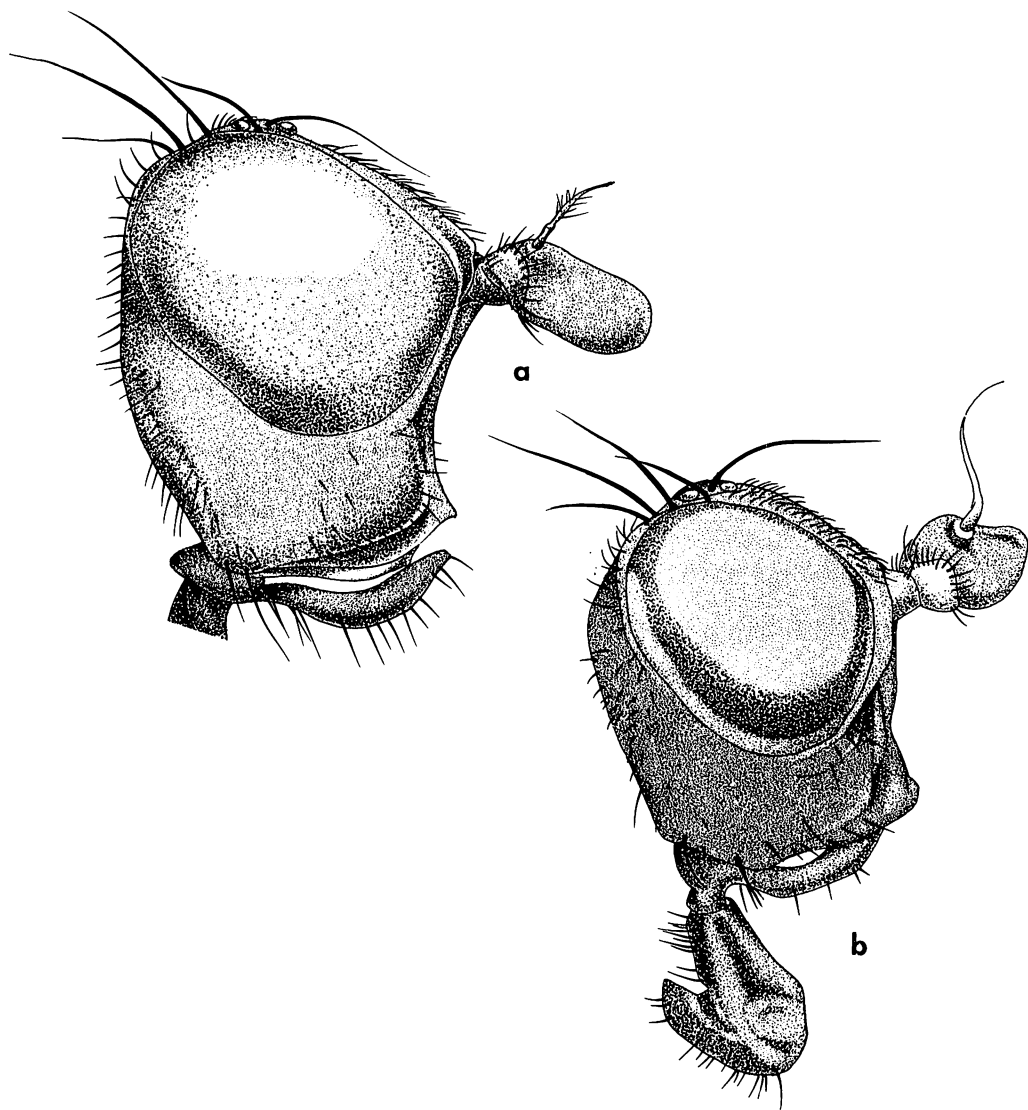


Figure 44—*Arichomelina pubera* (Loew): a, head. *Pherbellia parallela* (Walker): b, head.

September 21, 1961 (Davis and Krauss, 1926b:127). It has not been recovered.

Distribution: Widespread over the United States, southern Canada, and Mexico.

Differentiated by the generic characters given above. This species has the r-m and m crossveins clouded with brown. The arista is moderately long pubescent and the head is shaped as in figure 44a. Abdomen brown with posterior margins of terga yellow-gray.

This is one of the most common species of marsh flies over the United States. The biology and descriptions of immature stages have been treated by Foote et al. (1960).

Genus **PHERBELLIA** Robineau-Desvoidy

Pherbellia Robineau-Desvoidy, 1830, Acad. R. des Sci., Mem. présentes par divers Savans [Ser. 2.] 2:695. Type-species, *venalis* Robineau-Desvoidy, by monotypy, = *schoenherri* (Fallén).

Fitting near *Atrichomelina* Cresson, but with the propleural bristle well developed; front coxa with one or more dorsal bristles; arista bare or only microscopically pubescent; front tarsi all black; and the sternopleura and propleura sparsely setose.

For biology of *Pherbellia* refer to Bratt, et al., 1969.

Pherbellia dorsata (Zetterstedt) (fig. 45c)

Sciomyza dorsata Zetterstedt, 1846, Dipt. Scand. 5:2096.

Not known to be established.

Purposely introduced, under *Sciomyza*, from Denmark as a natural enemy of freshwater snails. Released on Oahu, December 9, 1960 but has not been recovered (Davis, 1961b:390). “*S. dorsata* attacks pulmonate snails that have either voluntarily left the water or have been stranded by receding water levels.”

Distribution: Europe and Siberia.

Differentiated from other species which have been introduced into Hawaii by the characters given above. Sack (1939:14) keys *dorsata* in the species group which has the mesopleura setose along posterior margin, and differentiates it by having the body brownish gray pollinose, with back of head, pleura, and apex of abdomen mostly reddish brown; arista plumose; lacking an extra bristle just beyond preapical dorsal bristle of hind tibia and vein $Cu_1 + 1st\ A$ only slightly over half as long as vein $M_3 + 4$. The head is shaped as in figure 45c. The r-m crossvein is situated beyond middle of cell 1st M_2 and a faint tinge of brown is present on r-m and m crossveins.

Pherbellia parallela (Walker) (fig. 44b)

Sciomyza parallela Walker, 1852, Insects Saundersiana 1:401.

Not known to be established.

Purposely introduced, as *grisescens*, from California as a natural enemy of liverfluke snails. Released on Oahu, Hawaii, and Kauai, September, 1961 (Davis and Krauss, 1962b:127) but has not been recovered.

Distribution: Nearctic region.

Differentiated from other species which have been introduced by the generic characters given above. Head as in figure 44b. Wings subhyaline, lacking dark markings. Front golden-orange with a silver margin along each orbit and a silver mark through middle from ocellar triangle. For taxonomic notes on the male terminalia refer to Steyskal (1963b).

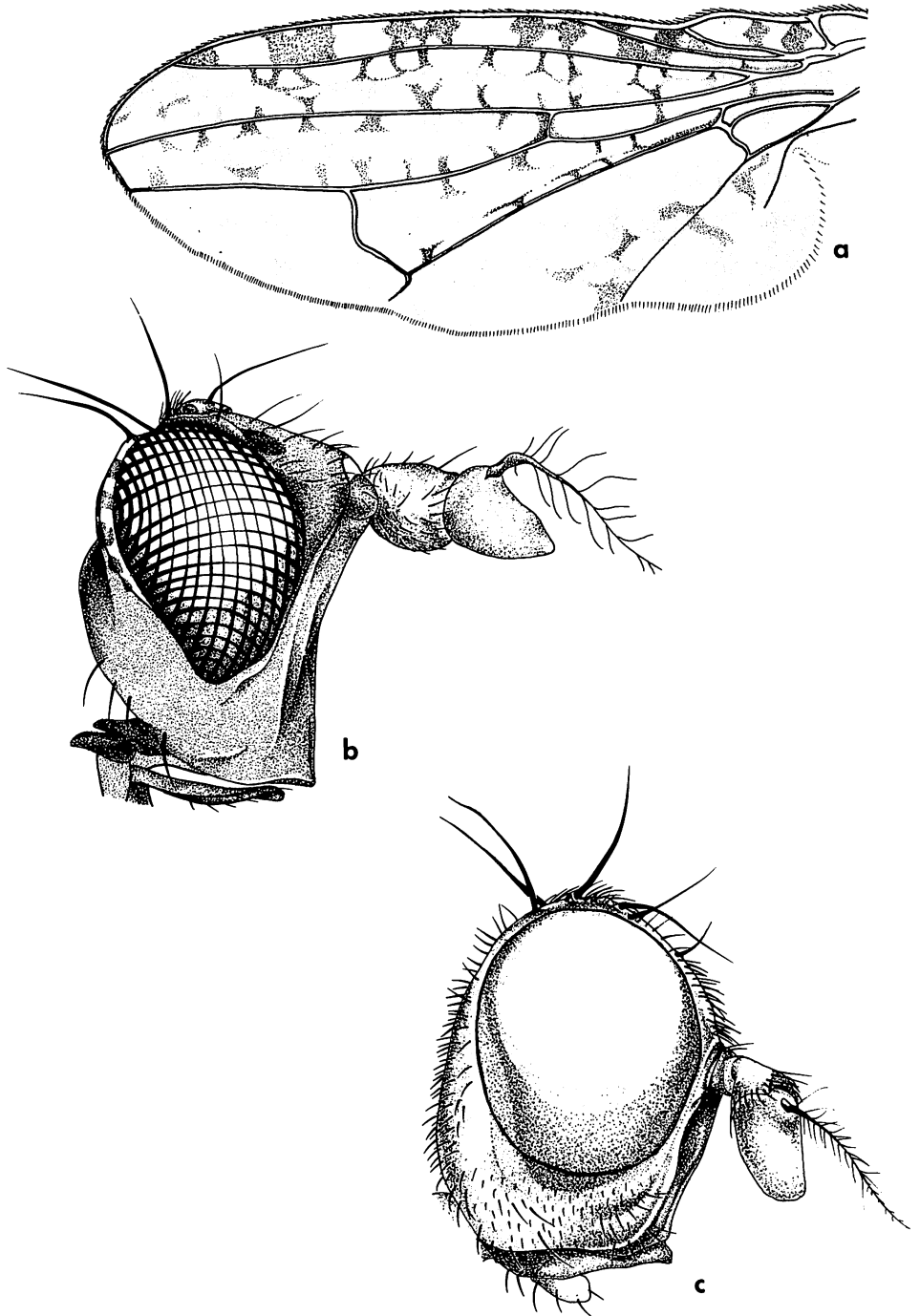


Figure 45—*Dictya abnormis* Steyskal: a, wing; b, head. *Pherbellia dorsata* (Zetterstedt): c, head.

Genus **DICTYA** Meigen

Dictya Meigen, 1803, Mag. f. Insekten. 2:277. Type-species, *Musca umbrarum* Linnaeus (action of I.C.Z.N. needed to preserve *Dictya*).

Characterized by having wings brown with numerous hyaline spots; scutellum with four bristles and with strong ocellar, humeral, presutural, prescutellar bristles, and one mesopleural and one pteropleural bristle; fifth tergum short, about one-third as long as sixth (fused 6th and 7th) and fifth sternum of male, with a pair of densely chaetose pads; head higher than long and face with a small black central spot.

The American species have been monographed by Steyskal (1954b).

Dictya abnormis Steyskal (figs. 45a-b)

Dictya abnormis Steyskal, 1954, Ann. Ent. Soc. Amer. 47:518.

Not established.

Purposely introduced from Ithaca, New York (a laboratory colony) for biological control of liver fluke snails. Released on Oahu, June 30, 1958 (Davis, 1960:245). It has not been recovered.

Distribution: Mexico.

Head shaped as in figure 45b. Front yellow with an opaque black spot on each side medianly. Face, genae, and lower occiput silvery except for opaque black median spot on face and a large brown spot on each gena below eye margin. Wings brown, covered with hyaline spots (fig. 45a). Body and femora gray pollinose with a small brown spot at base of each seta. Second antennal segment longer than high and shining on posterior surface. This is differentiated from two other closely related species from Guatemala and Puerto Rico mainly by differences in the male genitalia. Refer to Steyskal (1954b: 520-522).

Genus **SEPEDOMERUS** Steyskal

Sepedomerus Steyskal, 1973, Ent. News 84:144. Type-species, *Sepedon macropus* Walker, by original designation.

This is differentiated from others of the *Sepedon* group of genera by lacking postocellar bristles and having the minute setae of mid femora all of equal size.

Sepedomerus macropus Walker (figs. 46a-d)

Sepedon macropus Walker, 1849, List Ins. Brit. Mus. (Nat. Hist.) 4:1078.

Sepedon nigriventris van der Wulp, 1896, Biol. Centr. Amer. 2:359.

Oahu, Maui, Kauai, and Hawaii.

Purposely introduced from Nicaragua for biological control of liver fluke snail, *Galba viridis* (Quoy and Gaimard). First released on Oahu (Davis, 1959:63) and first recovered eight months later (Davis, 1960:244). It is now

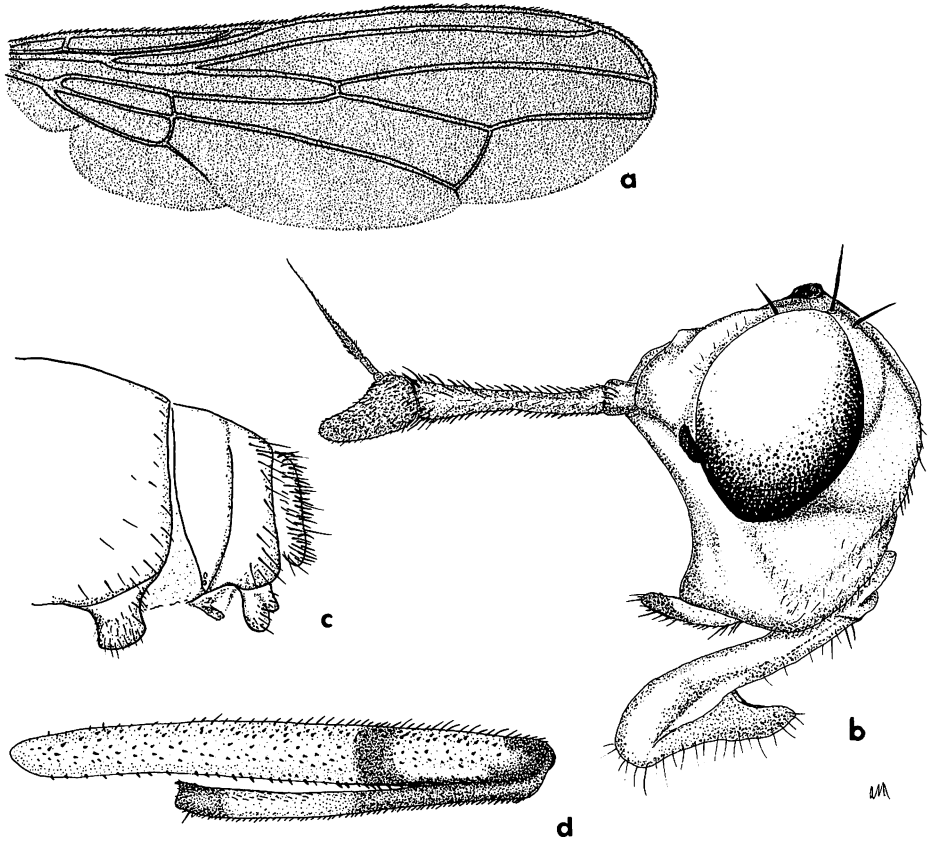


Figure 46—*Sepedomerus macropus* Walker: a, wing; b, head; c, male genitalia; d, hind femur and tibia.

well established on the main Hawaiian islands (Davis, 1961b:389) and it appears that it will be an important agent in control of liver flukes (*Fasciola gigantica* Cobbold) in Hawaii.

Distribution: Neotropical Region and Texas.

For biological data refer to Neff and Berg (1966:38) and Chock, Davis, and Chong (1961).

The species is differentiated by having the middle of the front completely bare, with short sparsely placed setae only laterad of the longitudinal ridges marking off median depressed area; hind femora elongate, half again as long as abdomen and extending as far as wing tips; third antennal elongate, slender, about five times longer than wide and almost as long as the face; hind femora black at apex and with a blackish preapical ring; front with sharp longitudinal ridges and pleura bare, or nearly so, except for metapleura.

Head and antennae as in figure 46b. Thorax mostly gray pollinose with a slightly metallic sheen in the gray stripes down sides of mesonotum. A broad

brown median vitta extends almost full length of mesonotum and over middle of scutellum. Lateral margins of mesonotum and dorsal margin of each pleuron opaque brown. Humeri rufous, tinged with brown. Halteres yellow. All femora and tibiae blackened at apices; hind femora and tibiae as in figure 46d. Wings evenly tinged brownish yellow, venation as in figure 46a. Abdomen reddish brown, tinged with black in ground color, lightly gray pollinose and with a faint metallic blue sheen. Male genitalia as in figure 46c.

Length: body, excluding antennae, and wings, 6.3–7.0 mm.

Genus **SEPEDON** Latreille

Sepedon Latreille, 1804, Soc. Nat. Agric. Nouv. Dict. hist. nat. 24:196. Type-species, *Syrphus sphegeus* Fabricius (by monotypy).

Members of the *Sepedon* group are readily recognized by their long porrect antennae (fig. 50a); large conspicuous hind legs; rows of ventral spines on femora; scutellum with only two bristles; ocellar bristles rudimentary or lacking; lacking humeral, presutural, pleural, or abdominal bristles; and the arista pubescent. *Sepedon* is differentiated from *Sepedomerus* by the characters given in the key above.

Three species have been introduced into Hawaii; only two are known to be established.

For a new classification of the *Sepedon* group refer to Steyskal (1973) and for a revision of the new world species refer to Steyskal (1951) and Fisher and Orth (1972). For biology and immature stages refer to Neff and Berg (1966) and to Beaver et al. (1977).

KEY TO SPECIES OF SEPEDON AND SEPEDOMERUS WHICH HAVE BEEN INTRODUCED INTO HAWAII

1. Second antennal segment elongate (fig. 50a), about five times longer than wide and about equal in length of face. Pleura bare or nearly so except for setose metapleura in some species. 2
- Second antennal segment comparatively short and thick (fig. 48a), less than three times longer than wide and much shorter than face. Propleura setose in front of mesothoracic spiracle, and hind portion of mesopleura and upper portion of sternopleura with scattered erect setae. Body tinged with rufous, five indistinct gray vittae on mesonotum. 6
2. Head and appendages predominantly yellow to rufous. 3
- Head and appendages shining black, except for

- yellowish scape of antenna and white apical portion of arista. **sauteri** Hendel.
3. Upper face and/or front, with a pair of velvety black spots (figs. 47a-c). 4
 Face and front lacking spots. 5
4. Front shiny, entirely yellow to rufous and with sharp, well-defined longitudinal ridges and median portion bare. Postocellars absent. Femora blackened at apices, hind pair with preapical blackish rings and elongate (fig. 46d), much longer than abdomen.
 **Sepedomerus macropus** Walker.
 Front gray pollinose with a large velvety black spot on each side medianly; with longitudinal ridges poorly developed, rounded, and lower median portion above the short transverse carina with scattered setae. Femora yellow to rufous, the hind pair distinctly thickened and scarcely longer than abdomen. **oriens** n. sp. Steyskal.*
5. Basitarsus of front legs of male strongly flattened and distinctly twisted (fig. 49a). Male genitalia as in figures 49b, c. Apical half of wing darker brown fumose than basal portion and no darker clouding on crossveins.
 **plumbella** Wiedemann.*
 Basitarsus normal (fig. 51a), male genitalia as in figures 51b, c. Wing darker clouded only beyond m crossvein and with brown clouding over both crossveins. **senex** Wiedemann.*
6. "Face yellowish to amber, with or without scattered fine black hairs on medifacies—may be totally bare; wing length males 5.8–7.2 mm., females 6.3–7.3 mm.; hind femur usually less than 4 mm." Male surstylus pointed, as seen in lateral view (fig. 49f). Apical portion of the aedeagus with the anterior lobe gently concaved, as seen in end view (fig. 49h); and hypandrium rather quadrate, truncate at apex as seen in side view. . .
 **praemiosa** Giglio-Tos.*
 "Face amber to brownish, medifacies with fine black hairs [fig. 48a] scattered to moderate dense; wing length males 7.2–8.9 mm., females 7.0–8.0 mm.; hind femur usually greater than 4 mm."

*Liberated in Hawaii but not known to be established.

Surstylus rounded apically (fig. 49c); anterior lobe of aedeagus with a prominent U-shaped concavity in middle (fig. 48e) and hypandrium gradually tapered to a broadly rounded apex. . . .
 **pacifica** Cresson.*
 (The above key characters quoted from Fisher and Orth, 1972:13)

Sepedon aenescens Wiedemann (figs. 50a-d)

Sepedon aenescens Wiedemann, 1830, Aussereurop. Zweifl. Insect. 5:579.
 Type-locality: China.

Oahu, Maui, Molokai, Hawaii, and Kauai.

Purposely introduced as *sauteri* Hendel from Japan, September, 1966 (Davis, 1967:375) for biological control of liver fluke snail, *Galba viridis* (Quoy and Gaimard). First recovered in Hawaii, August, 1967, on Oahu (Funasaki, 1968:15). On Hawaii (Kulani, 5200 ft.) it has been associated with the zoonitid snail, *Oxychilus alliarius*. Parasitized by *Trichogramma* sp. probably *japonicum* Ashmead (Davis, 1971:60).

Distribution: Originally described from Formosa, widespread throughout the Oriental Region; Japan, and the Ryukyus.

Recognized by having the head and body shiny black and predominantly black antennae, palpi, and mouthparts. Pleura almost bare except for setose metapleura. Femora and tibiae yellow to rufous except for tinge of brown on apices of tibiae. Head as in figure 50a. Thorax metallic blue-black, lightly gray pollinose lacking distinct longitudinal vittae. Scutellum almost bare. Wings as in figure 50c, brownish fumose, slightly darker apically and over r-m cross-vein. Hind femur about equal in length to abdomen, with ventral spines on apical three-fifths (fig. 50d). Male genitalia as in figure 50b.

Length: body, 7.0–8.0 mm.; wings, 6.5–7.0 mm.

Sepedon noteoi Steyskal, **new species** (figs. 47i-j)

MALE. Differs in very little else than postabdominal characters from *oriens*, either in size, coloration, or structure. Forefemur with only one or two distinct posteroventral setae near tip; other setae in the row are minute and hair-like. Hind tibia with apical and medial brown bands distinct, although not dark. Postabdomen as in figure 47i, differing only in detail from that of *S. oriens*; cerci with slender clavate apical process. Sternum 5 (fig. 47j) somewhat larger than that of *oriens*, with broader and thicker lateral border and with small denticle where the lateral border turns mesad along anterior margin.

FEMALE. Differs from male only in sexual characters.

Holotype and allotype on same pin, China: "Yim Na San, E. Kwantung, S. China, VI-13'36" (photographically reduced typewritten label), and one female paratype, same locality, VI-10'36, all from A. L. Melander collection,

*Liberated in Hawaii but not known to be established.

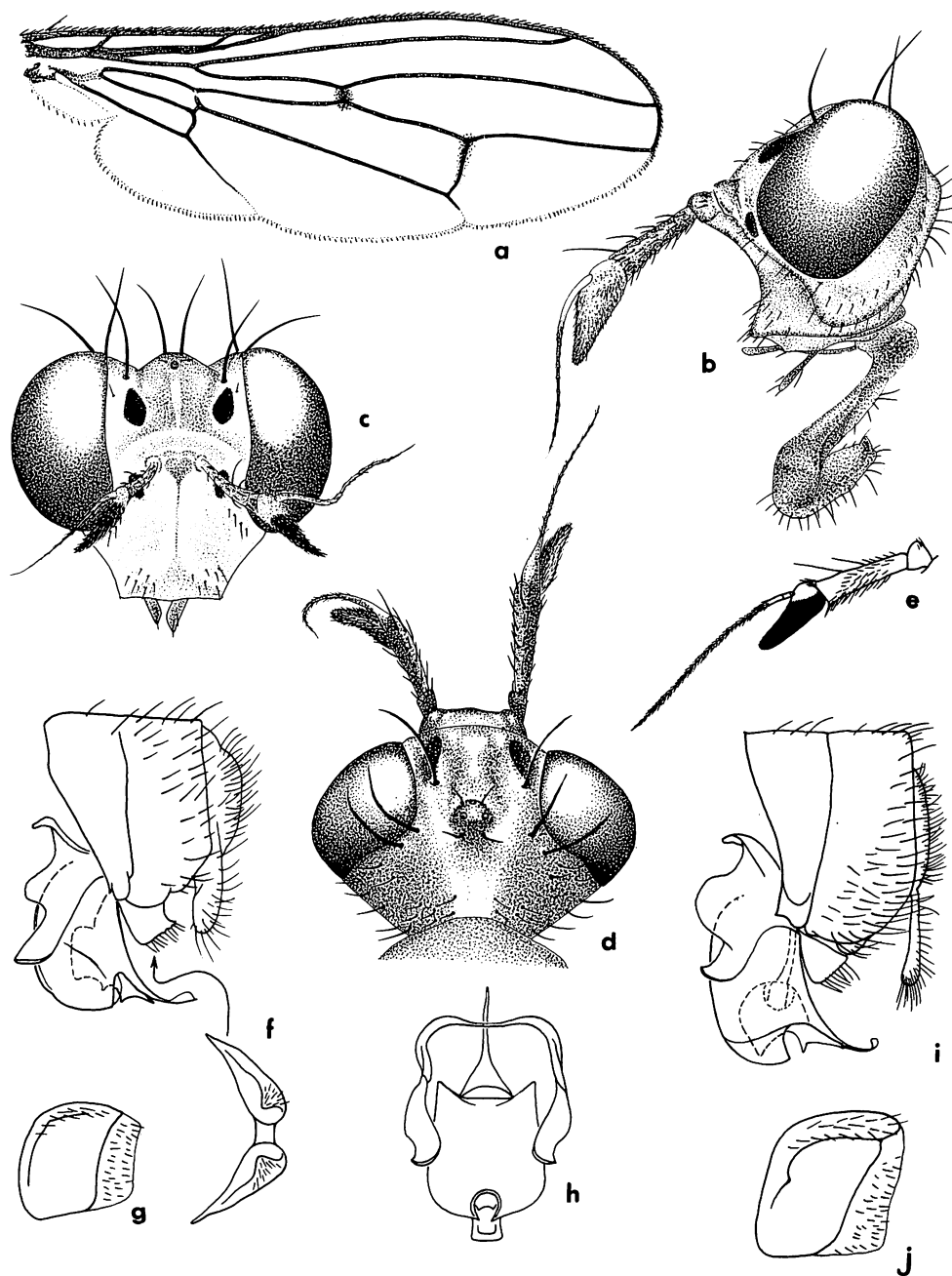


Figure 47—*Sepedon oriens* Steyskal, n. sp.: a, wing; b, head, lateral; c, head, anterior; d, head, dorsal; e, antenna; f, male genitalia, lateral, with ventral view of surstylus; g, left division of fifth sternum; h, aedeagus and hypandrium. *S. neleoi* Steyskal, n. sp.: i, male genitalia, lateral; j, left division of fifth sternum.

type no. 72507 in U.S.N.M.; one male, Hangchow [Hang-chou, Chekiang], June 20, 1934, No. 82, in U.S.N.M. A female specimen from Urai, Formosa, April 4, 1932, is also in U.S.N.M. from the Melander collection, but has not been designated a paratype.

The name *noteoi*, accented on the second "o," is the genitive of *noteous*, latinized from Greek *notos* "south" + *eoos* "Orient."

***Sepedon oriens* Steyskal, new species (figs. 47a-h)**

Because of the distinct setae on the pleurotergite (dorsad of posterior thoracic spiracle) and the lower part of the face, this species shows relationship to the palaearctic *S. sphegea* Fabricius, type of the genus, and to the eastern palaearctic and oriental forms of that species known as *aenescens* Wiedemann, *imbuta* Wiedemann, *sauteri* Hendel, *violacea* Hendel, and *chinensis* Meyer. These latter taxa, which are likely merely races or varieties of *sphegea*, share with it the characters of black face, front, and forecoxae. *S. oriens* is also closely related to the North American *S. pusilla* Loew and its relatives. *S. oriens* is readily differentiated by the characteristics of the male genitalia, as shown in figures 47f-h.

Differentiated from other *Sepedon* in Hawaii by the pair of large velvety black spots in median portion of front. It somewhat resembles *macropus* Walker but differs by having the front gray pollinose, tinged with brown to blackish, the frontal ridges poorly developed, rounded and lower median portion of front above the short transverse carina with scattered setae. Also, the femora are all yellow to rufous and the hind pair comparatively short and thick, scarcely longer than the abdomen. The hind tibiae are distinctly curved along ventral margin. The knobs of the halteres are blackish and the male genitalia are distinctive as shown in figures 47f-h.

MALE. Length of wing, 4.5-5.0 mm. Color brown to yellowish, only following parts black: foretarsus (wholly), last two segments of mid- and hind-tarsi, lower half of thick basal part of third antennal segment, and entire slender part from short distance beyond insertion of arista, dull oval spot on parafrontal laterad of ridge between base of fronto-orbital bristle and transverse sulcus near anterior margin of front, dull round spot on parafacial just below level of antennal insertion. Color palest on lower half of head and on forecoxa. Surface lightly tomentose, whitish on pleura, denser and brownish on mesoscutum except for broad grayish stripes on dorsocentral lines. Medifrons, lower one-third of face, humerus, legs beyond coxae, and abdomen very thinly tomentose, shining. Wing pale brownish, with distinctly darker brown seams on anterior and posterior crossveins. Hind tibia usually with faint indication of brown apical and medial bands. All setae black. **Head:** (figs. 47b-d) Front with a pair of weakly convergent broad ridges, approximately 100° in cross section, extending from close before base of the single fronto-orbital bristle toward base of antenna, but stopping just before complete transverse sulcus near anterior frontal margin. Several well-developed black setae about parafrontal black

spots and across front behind transverse sulcus. Face deeply concave, oral margin in profile 70° . Single row of fine setae extends along entire parafacial suture and several stronger setae are scattered about sides and lower margin of face. Antenna, as in figures 47b, e, slender when deflexed lower apical margin of second segment attains level of anterior oral margin. Arista yellowish near base, slender apical part white and with white pubescence. *Thorax*: With one pair each of dorsocentral, supraalar, and postalar bristles; two notopleurals, anterior one only slightly smaller than posterior; humeral, sublateral, and acrostichals lacking; complete row of small dorsocentral hairs and two approximated irregular rows of small acrostichal hairs. Pleurotergite with several rather long bristly setae. *Legs*: With posterior tibia bowed to extent of medial tibial diameter; hind femur with double row of ventral spinules in apical half; midfemur with one mid-anterior bristle and three to six small posteroventral spinules; forefemur with complete row of fine posteroventral setae, four to five near tip larger and more bristle-like. *Wings*: As in figure 47a. *Abdomen*: Rather uniformly covered with short black setae, those of third tergum in about five irregular transverse rows. Postabdomen as in figures 47f, h, surstyli fused mesally by bridge-like connection, cerci fused into structure bearing two rounded apical lobes. Sternum 5 (fig. 47g) narrowly divided on meson, heavily sclerotized and with narrow thickened lateral margin in more than basal two-thirds; apical part thin and bearing numerous small setae.

FEMALE. Differing from male only in sexual characters.

Holotype, allotype, and 500 paratypes, Philippines: Abatan, Buguias, 60 km. S Bontoc, Mountain Province, Luzon, 1800–2000 m., April 1–June 19, 1964 (H. M. Torrevillas), in B. P. Bishop Museum (holotype, May 7), except 25 retained in U.S.N.M.; additional paratypes: one pair, La Trinidad, Luzon, April 4–5, 1968 (M. D. Delfinado), in B. P. Bishop Museum; Japan: one pair, Ajime (near Nagoya, Aichi Prefecture) May 26, 1971 (H. Nakao), in U.S.N.M.; one female, Sakata, Yamagata Prefecture, September 8, 1954 (K. S.), in Zoological Institute, University of Lund, Sweden; China: one male, Suifu, Szechwan (D. C. Graham) and one female, Kuanshien, Szechwan, 2000 ft., November 20, 1933 (D. C. Graham); both in U.S.N.M. The Ajime, Japan specimens are from a lot purposely introduced into Hawaii for control of the liverfluke snail, *Galba viridis*. It was released on Kauai, Oahu, Maui, Molokai, and Hawaii July, 1972 (Davis, 1972), but is not known to be established.

The name *oriens* is a single-form Latin adjective (participle of verb *orior*) meaning “rising, appearing, coming forth” and is also used as a noun meaning “rising sun, the East, Orient.”

The following species is deceptively similar to *S. oriens*.

***Sepedon pacifica* Cresson (figs. 48a–e)**

Sepedon pacifica Cresson, 1914, Ent. News 25:457. Type-locality: Marin Co., California.

Maui.

Immigrant. Western half of United States from Iowa to California, also

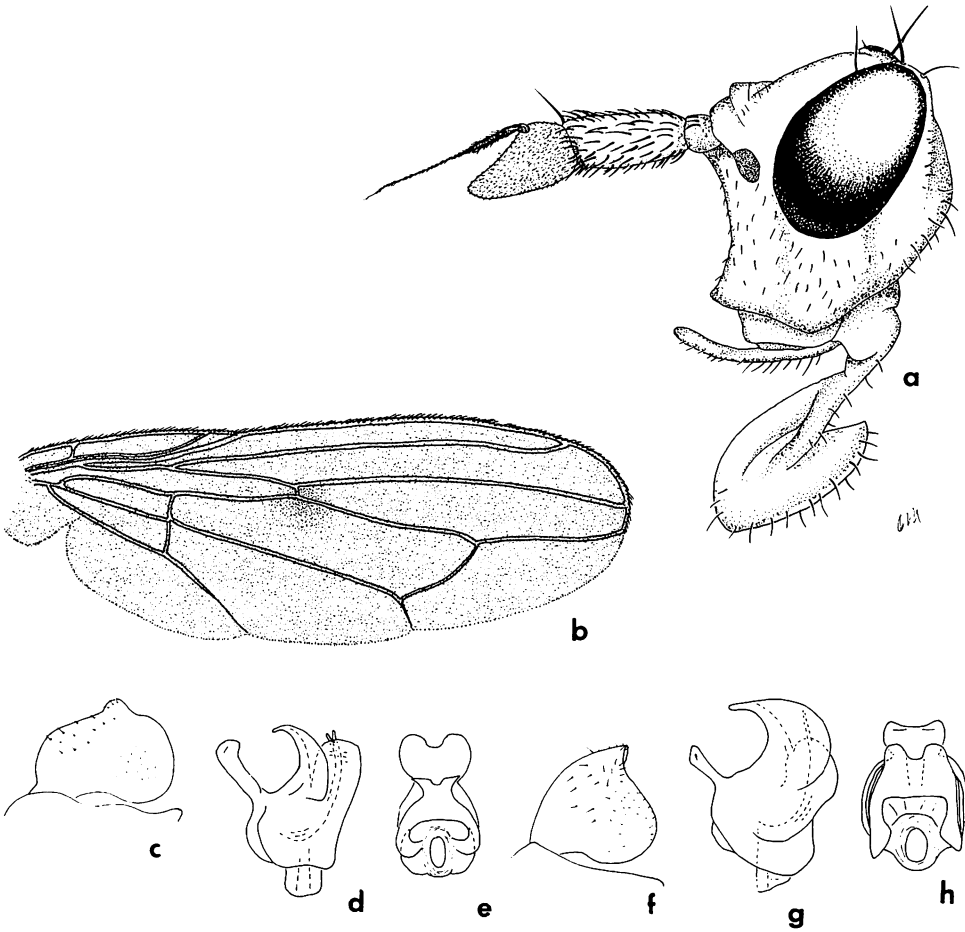


Figure 48—*Sepedon pacifica* Cresson: a, head; b, wing; c, surstylus of male; d, apex of aedeagus, lateral; e, apex of aedeagus, end view. *S. praemiosa* Giglio-Tos: f, surstylus of male; g, apex of aedeagus, lateral; h, aedeagus, end view. (Figs. c-e, f-h copied from Fisher and Orth, 1972.)

from Northern Baja California del Norte, Mexico to northwestern Washington and western British Columbia, Canada.

Introduced from California and liberated at Waihee, Maui in September, 1970 (Davis, 1971:61), but has not yet been recovered.

Fitting in the group of species characterized by having the second antennal segment comparatively short, about three times longer than wide and shorter than the face (fig. 48a); hind femora comparatively short and thick, not much longer than the abdomen and extending only about as far as the m crossvein when compared to length of wing; supraspiracular convexity of metathorax with black hairs and propleura in front of mesothoracic spiracle with numerous black hairs; wings smoky, darker over r-m crossvein and with last section of vein $M_1 + 2$ slanted upward narrowing apical portion of cell R_5 (fig. 48b).

Very close to *praemiosa* Giglio-Tos and previously treated as a synonym of this species (ref. Steyskal, 1951:278, 1965a:693). Fisher and Orth (1972) resurrected it from synonymy. They state that it is in general larger and darker colored than *praemiosa*. The characters used in their key and shown in their figures for separating this from *praemiosa* are as given above in the key to species. We are unable to confirm these differences. We find considerable variation in facial coloration and setation and apparently in the genitalic characters in the series available for study.

Both species also have the following characters in common: Head as in figure 48a, except that the face is usually bare in the middle in *praemiosa*. Frontal ridges rounded, not sharp. Face with a velvety black spot on each side. Thorax brownish red with five narrow, rather faint gray longitudinal vittae on mesonotum and pleura evenly grayish pollinose. Propleura with numerous erect black hairs in front of mesothoracic spiracle. Hind portion of each mesopleuron, pleurotergon, and upper sternopleuron with rather numerous, short, inconspicuous setae. Legs all rufous. Wings fumose with a slight tinge of brown over r-m crossvein (fig. 48b). Abdomen rufous to blackish, with a faint metallic sheen.

***Sepedon plumbella* Wiedemann (figs. 49a-c)**

Sepedon plumbella Wiedemann, 1830, Aussereur. Zweifl. Ins. 2:577. Type-locality: China.

Released on Oahu and Kauai, August, 1971 (Davis, 1972:188), but not known to be established.

Immigrant. Widespread over Oriental Region, Ryukyus, Hong Kong,

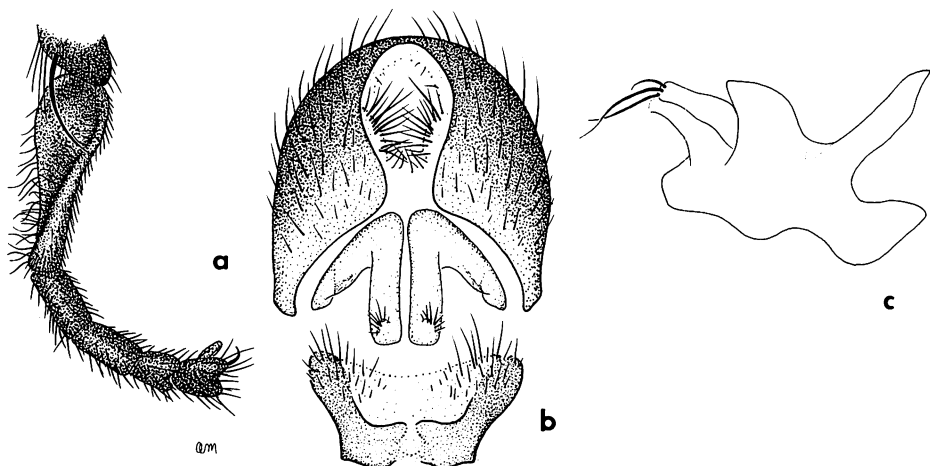


Figure 49—*Sepedon plumbellus* Wiedemann: a, front tarsus of male; b, male genitalia, ventral (aedeagus and hypandrium removed); c, hypandrium, lateral.

New Guinea. It apparently occurs commonly in rice fields (Nishida and Torii, 1970).

Fitting very close to *senex* Wiedemann in group of species which have the pedicel of antenna long and slender, face and front lacking velvety black spots; front lacking distinct ridges, pleura bare, lacking black setation; and male surstyli bilobed. Differentiated from *senex* by the strongly flattened, twisted front basitarsus (fig. 49a) and differences in genitalia of the male (figs. 49b, c). The fifth sternum is narrow, sparsely setose, with a deep concavity on hind margin and indistinctly divided into two plates medianly. The surstyli are straight-sided, rather sparsely setose except on the preapical tubercle and other details as in figures 49b, c.

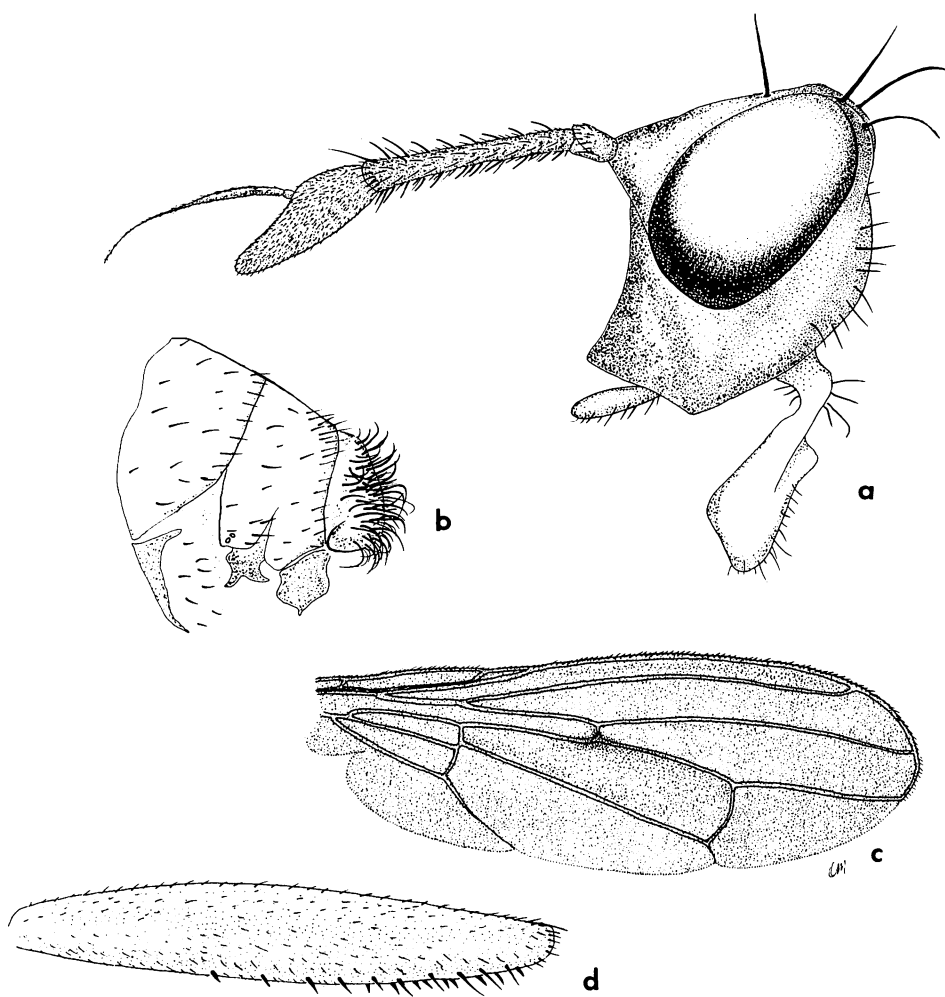


Figure 50—*Sepedon aenescens* Wiedemann: a, head; b, male genitalia; c, wing; d, hind femur.

We find no characters which appear to be reliable for separating the females of *plumbella* and *senex*. Nishida and Torii (1970:35) indicated that females of *plumbella* could be differentiated by having the front basitarsus longer than the second tarsomere, rather than two times longer or less. We find this of no value.

***Sepedon praemiosa* Giglio-Tos (figs. 48f-h)**

Sepedon praemiosa Giglio-Tos, 1893, Bol. Mus. Zool. ed. Anat. Comp. [Turin Univ.] 8(158):8.

Not known to be established.

Purposely introduced from California for biological control of liver fluke snails. Released on Oahu, Hawaii, and Kauai, October, 1961 (Davis and Krauss, 1962b). It has not been recovered to date.

Distribution: widespread over United States, southern Canada, and Mexico.

For biological data refer to Neff and Berg (1966:47).

The statement made under *pacifica* would also fit here. The characters used for differentiating it are given in the key above but based upon the series of specimens available for study; we have not been able to assess the reliability of these characters.

***Sepedon senex* Wiedemann (figs. 51a-c)**

Sepedon senex Wiedemann, 1830, Aussereur. Zweifl. Ins. 2:578. Type-locality: unknown.

Released on Hawaii, December, 1971 (Davis, 1972:188) but not known to be established.

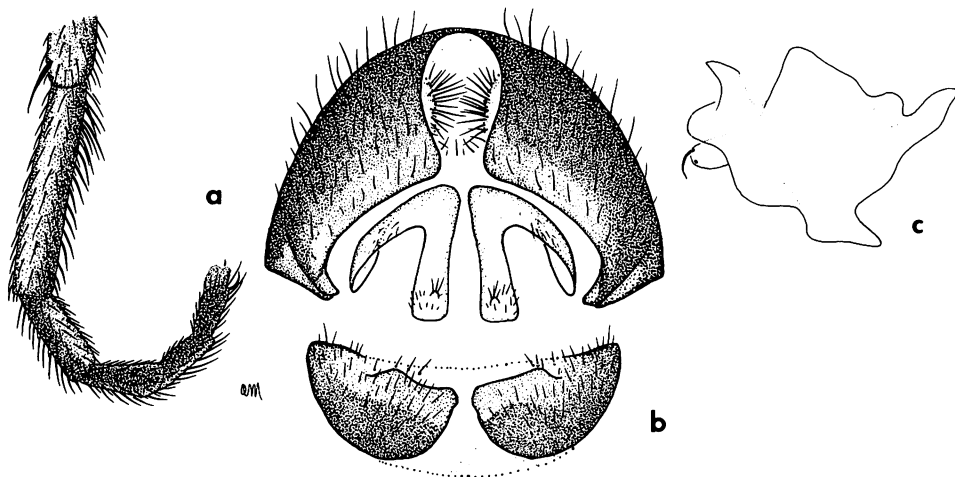


Figure 51—*Sepedon senex* Wiedemann: a, front tarsus of male; b, male genitalia, ventral (aedeagus and hypandrium removed); c, hypandrium, lateral.

Immigrant. Widespread over Oriental Region; Hong Kong. It apparently occurs commonly in rice fields (Nishida and Torii, 1970).

Similar in most respects to *plumbella* Wiedemann but with the front tarsi of males normal (fig. 51a). The fifth sternum divided into two suboval densely setose plates. Surstylus thickened apically and with rather abundant setae. Other details as in figures 51b, c.

Family CHAMAEMYIIDAE (Ochthipilidae)

Small, usually densely gray pollinose flies whose larvae are predators on aphids, scale insects, and mealybugs.

The only Hawaiian representatives of this family are recognized by, in addition to the gray color, lacking postocellar and fronto-orbital bristles; third antennal segment globose and arista short and thick (fig. 52b); costa not broken; subcosta complete, ending in costa free of R_1 ; cubital cell not acutely pointed and vein $Cu_1 + 1st\ A$ abbreviated; tibiae lacking preapical bristles and male genitalia as in figures 52c, 53d.

Only the genus *Leucopis* Meigen is known from Hawaii. According to McAlpine's classification (1963:250) this fits in the subfamily Chamaemyiinae, tribe Leucopini. The members of this tribe are characterized by having the lunule setose, broad and exposed, the frons emarginate anteriorly, and by usually lacking fronto-orbital bristles.

For a diagnosis of this family and comparison with related groups refer to Czerny (1936) and McAlpine (1963). For a generic key refer to Malloch (1921, 1940b), McAlpine (1960b), and Smith (1963). For a discussion of male genitalia refer to Hennig (1938).

Dr. J. F. McAlpine, Canada Dept. of Agriculture, has studied the Hawaiian collections and has clarified the taxonomic status of our species.

Genus LEUCOPIS Meigen

Leucopis Meigen, 1830, Syst. Besch. europ. Zweifl. Ins. 6:130. Type-species, *Anthomyza griseola* Fallén, by designation of Blanchard (1840:627).

Characterized from other genera by having the lunule very broad, conspicuous, and at least sparsely setose; fronto-orbital and postocellar bristles lacking, also lacking ocellars in males; proscutellum present; costa extending to vein $M_1 + 2$; cell 1st M_2 not confluent with cell M ; mesopleura bare; and front and body densely gray pollinose. Male with aedeagus pointed, rigid, and slender. Surstyli fused with epandrium. Aedeagal apodeme large, not fused with hypandrium. Gonophyses pointed, subequal. Female with four spermathecae.

According to McAlpine (1960b:54) members of the typical subgenus are differentiated by lacking ocellar bristles, except for weak bristles in females of *ocellaris* group of species; by lacking orbital bristles or setulae and prescutellar

acrostichals; also by having the ocelli evenly spaced, forming a nearly equilateral triangle, except in the *ocellaris* group of species.

KEY TO HAWAIIAN SPECIES OF LEUCOPIS

1. Prescutellar acrostichal bristles absent. Subgenus *Leucopis* Meigen. 2
 Prescutellar acrostichals present. Subgenus *Neoleucopis* Malloch. 3
2. Ocellar triangle setose, posterior ocelli widely spaced (fig. 53c); ocellar bristles present in female; male genitalia and female spermathecae as in figures 53b, d. Feeders on mealybugs. *ocellaris* Malloch.
 Ocellar triangle bare; ocelli arranged in an equilateral triangle; ocellar bristles lacking in female; male genitalia and female spermathecae as in figures 52c, d. Feeders on aphids. *albipuncta* Zetterstedt.
3. All setulae of front and lunule, including ocellar bristles, black; ocellar bristles rather strong, subequal in length and strength to inner verticals; face all gray pollinose *obscura* Haliday.
 All setulae of front and lunule pale yellowish; ocellars weak, thin, hairlike, and not much larger than other setulae on ocellar triangle; face jet black in median portion. *nigraluna* McAlpine.

Subgenus **LEUCOPIS** Meigen

Leucopis (Leucopis) albipuncta Zetterstedt complex of species (figs. 52a-d)
Leucopis albipuncta Zetterstedt, 1855, Dipt. Scand. 12:4810. Type-locality: Europe.

Oahu, Maui, Kahoolawe, and Hawaii. Probably widespread over all of the Islands. We have records of specimens taken at 10,000 ft. on Haleakala, Maui and 4080-4140 m. on Mauna Loa and Mauna Kea, Hawaii (probably blown up on the mountains by winds).

Immigrant. According to McAlpine it occurs over western North America, California, Washington, and British Columbia.

Host: A predator on aphids.

Parasites: *Pachyneuron eros* Girault. See note under *ocellaris* Malloch.

This species has been consistently confused in the Hawaiian literature under the name *L. nigricornis* Eggar. Dr. J. F. McAlpine has identified our species as *albipuncta* complex (species #45). He says the complex is worldwide and much work needs to be done in order to sort it out.

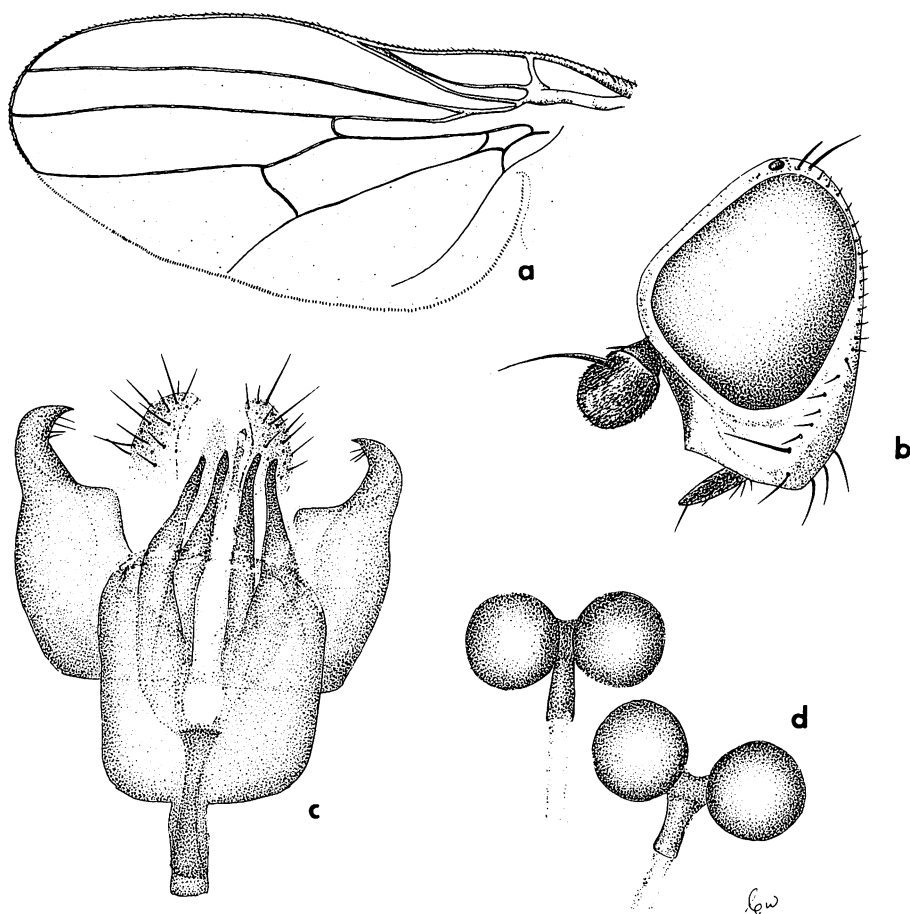


Figure 52—*Leucopis* (*Leucopis*) *albipuncta* Zetterstedt: a, wing; b, head, lateral; c, male genitalia, ventral; d, female spermathecae.

Belonging in a large complex of species which have a brown vitta down each side of mesonotum in line with dorsocentral bristles; first two terga largely dark gray to blackish, contrasting from silvery gray on remainder of abdomen and a pair of dark brown to black spots in middle of third tergum; legs largely brown to black in ground color with basitarsi and bases of tibiae yellow; and antennae black. The species is characterized by the distinctive genital characters; the two pairs of lobes from the hind portion of the hypandrium are long and slender, equal in size (fig. 52c). *L. albipuncta*, as characterized by Smith (1963:106–107, fig. 3), differs by having outer pair of lobes thickened, much broader than inner. Fitting the general characteristics of *Leucopis sens. str.* with the ocelli evenly spaced, the triangle bare, nearly half as wide as front, and the front with short, fine, inconspicuous yellow pile. The ocellar plate is more clearly defined and more distinctly pollinose in the female than in the male. Inner vertical bristles well developed, approximately three-fourths to four-fifths

as long as outer bristles. Interfrontal area dark gray to blackish; vertex, orbits, and lunule, as well as face, genae, and occiput densely gray pollinose. Front almost equal in width to one eye and distinctly narrowed on upper portion. The lunule is very broad and conspicuous and is sparsely and inconspicuously setose near the upper margin; measured to bases of antennae it is slightly over half as long as front. The lower median portion of the lunule is continuous with upper median part of face so the antennae are widely separated by more than the height of the second segment. The clypeus is black covered with gray pollen. Palpi dark brown to black, each with a short bristle at apex, otherwise inconspicuously covered with short fine setae. Labella, rufous, with long yellow setae around margins. Head approximately two times higher than long, shaped as in figure 52b. Antennae black in ground color. Genae bare, lacking setae in front of bristle. The lateral brown vittae on mesonotum are rather faint and extend from interior margins to just slightly beyond the anterior dorsocentral bristles; the hind portion of the mesonotum is entirely cinereous. The anterior dorsocentral bristles are short, slightly less than half as long as posterior bristles. Proscutellum prominent, developed as a narrow sclerite immediately anterior to the scutellum. The other details of the thorax are as is typical of this complex of species. The halteres are white. Legs mostly dark brown to black in ground color, densely gray pollinose over tibiae and femora. Front tarsi dark colored, typically dark brown to black, sometimes tinged with yellow on basal portion of basitarsi. Front and middle basitarsi yellow, second and third tarsomeres yellow, tinged with brown, fourth and fifth brown to black. Bases of tibiae and extreme apices of femora yellow. Wings as in figure 52a. Crossvein r-m situated near apical two-thirds of cell 1st M_2 . First two terga of abdomen dark dull gray to blackish except for the cinereous apical margin of second. Third tergum with a pair of submedian opaque dark brown to black spots and often with a single small, basomedian, subshining brown to black spot on each of terga four and five; the latter may not be typical and may be due to rubbing of certain specimens. Male genitalia as in figure 52c. Cerci yellow, triangular in shape as seen from direct lateral view, subacutely pointed. Surstyli fused with epandrium, slender, rather sharply pointed. Aedeagus short, rather thick over the basal three-fourths, narrowed, and slightly turned downward apically. The anterior and posterior lobes of the hypandrium are rather elongate and slender, two pairs of lobes approximately equal in size. First two sterna of male two times wider than long, concave on posterior margins. Sterna three to five longer than wide, each with about three pairs of prominent setae along lateral margins. Sterna six to eight are apparently fused into a small narrow plate fitting anterior to the hypandrium; this is about three times longer than wide. In the female the first sternum is narrow, with a deep U-shaped cleft on anterior margin. Second sternum about three times wider than long, gently concave on hind margin. Sterna almost two times longer than wide. Sixth sternum approximately two times wider than long, gently concave on posterior margin. Seventh sternum divided into two narrow plates, each is three to four times longer than wide. The four spermathecae are com-

paratively large; each pair is joined by a sclerotized connection almost equal in length to the width of a spermatheca and a short sclerotized neck connects with the duct (fig. 52d).

Length: body and wings, 2.5 mm.

Leucopis (Leucopis) ocellaris Malloch (figs. 53a-d)

Leucopis ocellaris Malloch, 1940, Ann. Mag. Nat. Hist. (11)6:272. Type-locality: Alberta, Canada.

Oahu, probably on other Islands.

Immigrant. Western North America, California, Washington, British Columbia.

Hosts: Apparently a scale insect and mealybug predator, it has been collected preying on *Dysmicoccus neobrevipes* Beardsley, on fruit of *Pritchardia pacifica*, Honolulu, April, 1960, on *Nipaecoccus vastator* (Maskell), and on *Gossypium tomentosum*, Koko Head, Oahu, September, 1960.

The notes of Fullaway (1909:25) and Williams (1931:307) relating to "*Leucopis nigricornis* Egger" being predacious on plant lice and certain scale insects no doubt, in part, pertained to *ocellaris*, but we have no records that they actually reared specimens from scale insects.

Parasites: *Pachyneuron eros* Girault recorded by Timberlake (1926:309) reared from specimens of *L. "nigricornis* Egger" from Honolulu. These were conspecific with specimens reared from *Leucopis* preying on *Lecanium corni* Bouché and on two species of *Pseudococcus* in California. He had earlier (1920) reported this as *Pachyneuron anthomyiae* Howard and as *Pachyneuron* sp. (1924a:425).

According to McAlpine (1960:54) the *ocellaris* group of species differ from other *Leucopis sens. str.* by having the ocellar "plate expanded and usually densely pilose; posterior ocelli usually much farther from each other than from the anterior ocellus; ocellar bristles absent in male, usually present but weak in female." In the specimens on hand the ocellar bristles are moderately developed in the females, equal in size to inner vertical bristles. This species is differentiated from other members of this complex by the male genital characters, as in figure 53d and as described below.

Head about two times higher than long. Front almost as wide as one eye, distinctly narrower at vertex than at lunule. In the male the entire front, the ocellar triangle, and the lunule are densely covered with short black setae (fig. 53c); the front is covered with longer black setae and with a few scattered setae over upper portion of lunule. The ocellar triangle and the broad median portion of the front are dark gray in color contrasted with the gray-white orbits and lunule. Mesonotum with a broad brown vitta extending down each side in line with dorsocentral bristles. Proscutellum prominent, but represented by a narrow sclerite anterior to base of scutellum. Coxae yellow-brown; femora and tibiae brown to black, gray pollinose; bases of tibiae and basitarsi yellow, other tarsomeres yellow-brown to black. Wing venation as in *albipuncta* Zetterstedt,

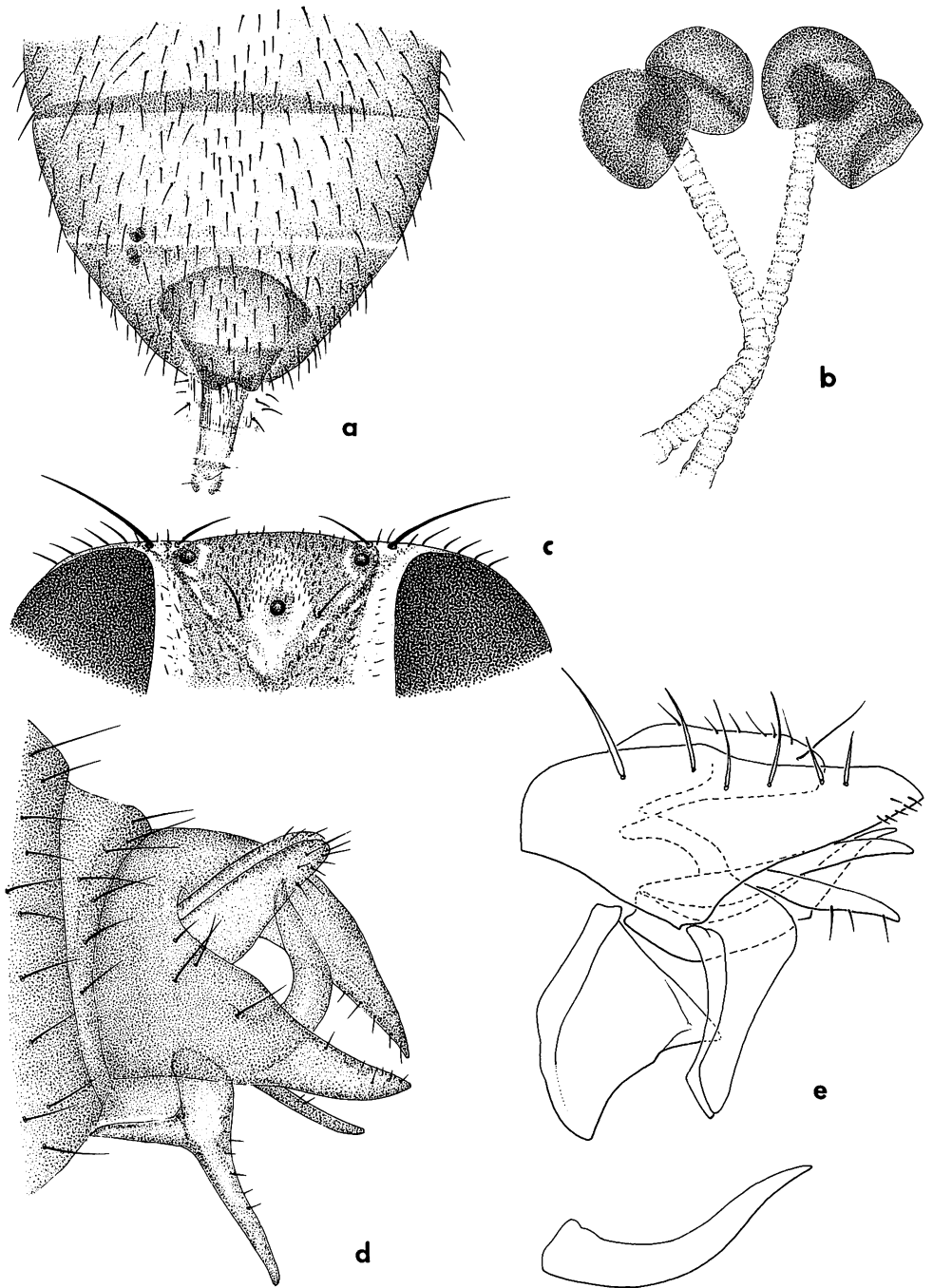


Figure 53—*Leucopis (Leucopis) ocellaris* Malloch: a, apical portion of female abdomen, dorsal; b, female spermatheca; c, upper portion of female head; d, male genitalia, lateral. *L. (Neoleucopis) nigratuna* McAlpine: e, male genitalia showing aedeagus separately (copied from McAlpine, 1971:1858, fig. 29).

except that the r-m crossvein is situated at apical two-fifths of cell 1st M_2 . Second and third abdominal terga each with three dull brown spots. Fourth and fifth terga each with a shining brown posteromedian spot. Male genitalia as in figure 53d. The surstyli are fused with the epandrium and slender, sharp-pointed, with scattered setae along inner apical margins. Hypandrium with a pair of strong, slender, sharp-pointed, diverging lobes on posterior margin; also, with a pair of shorter, anteriorly directed lobes. Aedeagus short and thick, strongly curved upward. Female with sterna one and two rather narrow, over two times wider than long. Third sternum approximately as wide as long. Fourth and fifth sterna distinctly longer than wide, one-third to one-half longer. Sixth sternum approximately two times wider than long with the hind margins straight or nearly so. Seventh sternum approximately two times wider than long with a U-shaped concavity on posterior margin (fig. 53a). Four spermathecae, in pairs; these are small compared to those of *L. albipuncta* Zetterstedt (figs. 52d, 53b), but are close together with a very short connection and with no sclerotized neck leading into the duct.

Length: body and wings, 2.5 mm.

Subgenus **NEOLEUCOPIS** Malloch

Leucopis, subg. *Neoleucopis* Malloch, 1921, Bull. Ill. St. Nat. Hist. Surv. 113(14):257. Type-species, *Neoleucopis pinicola* Malloch, by original designation.

Differentiated from typical *Leucopis* by having prescutellar acrostichal bristles and ocellar bristles present in both sexes. Refer to revision by McAlpine (1971).

The larvae are associated with pine aphids (Adelgidae).

Two species have been introduced as predators on *Pineus pini* Koch.

Leucopis (Neoleucopis) nigriluna McAlpine (fig. 53d)

Leucopis (Neoleucopis) nigriluna McAlpine, 1971, Can. Ent. 103:1857, fig. 29.

Type-locality: Shillong, Assam, India.

Immigrant. India and Pakistan. Purposely introduced in 1972 (Davis, 1974) to aid in control of *Pineus pini* Koch. Also introduced into U.S. against *Adelges piceae* (Ratzeburg). Both *nigriluna* McAlpine and *militia* McAlpine were recorded as released in the original introduction (Yoshioka, 1972). This was an error; only *nigriluna* was released. This has been recovered ex pine aphids, Kamuela, Hawaii, October, 1976 (Higa and Shishido, 1976) and Waimea, Hawaii, March, 1977 (Tanimoto, 1977).

According to McAlpine's key (1971:1852) to *Neoleucopis*, this species fits in the group which has the prescutellar acrostichals developed, the ocellar bristles rather weak, at least basal tarsomeres yellow, and lunule and face jet black. It fits close to *militia* McAlpine and is differentiated as follows:

“Ocellar hairs distinctly longer and stronger than adjacent hairs; distance between posterior ocelli greater than from latter to anterior ocellus; prescutellar acrostichals always easily distinguished from adjacent setulae”

. **militia** McAlpine.

“Ocellar hairs scarcely distinguishable from adjacent hairs; distance between posterior ocelli less than from latter to anterior ocellus; prescutellar acrostichals frequently indistinguishable from adjacent setulae” **nigraluna** McAlpine.

L. nigraluna is differentiated from *obscura* Haliday by having the head wider than high; the two posterior ocelli much closer together than they are to the anterior ocellus; antennae, lunule, and median portion of face jet black; all setulae of front and lunule pale yellow and ocellar bristles weak, thin, hairlike, scarcely differentiated from other setulae of the ocellar triangle. The female 7th sternum is entire, and the spermathecae are relatively small.

McAlpine's general description (*loc. cit.* 1857) is as follows: “Micaceous-grey species with jet-black lunule, antennae, and face; interfrontalia and parafrontals appearing blackish in some lights, grey in others, all setulae of frons and lunule pale, ocellars extremely weakly differentiated. Basal segment of each tarsus yellow. Length about 1.75–2.0 mm.” For further details refer to original description.

Leucopis (Neoleucopis) obscura Haliday

Leucopis obscura Haliday, 1830, Ent. Mag., London 1:150, 173. Type-locality: Ireland.

Leucopis hyalipennis Zetterstedt, 1848, Dipt. Scand. 7:2715. Type-locality: Sweden.

Maui. Introduced from France and released June, 1976, at Polipoli, Maui (Lai, in press). Recovered March, 1977, ex pine aphids, Polipoli, Maui (V. Tanimoto).

Immigrant. Europe.

Differentiated from *nigraluna* McAlpine by having the head higher than long and distinctly higher than wide; the ocelli nearly equidistant with anterior ocellus, slightly closer to posterior ocelli than the latter are to each other; lunule and face gray pollinose; all setulae of front and lunule black, and ocellar bristles relatively strong, subequal in length to inner vertical bristles. The females have the 7th sternum almost completely divided along the midline, and the spermathecae are moderately large.

In McAlpine's key (1971:1852) it fits near *freyi* McAlpine, from Switzerland and Finland, and differs by having the proscutellum present and by lacking a

prominent orbital bristle. For a detailed description and figures of the head and male genitalia refer to McAlpine (1971:1861, figs. 1, 2, 7, 10, 14-16).

Length: body, 1.75-2.0 mm.

Family LAUXANIIDAE

Rather small flies, worldwide in distribution and especially well developed in the tropics. Often confused with *Drosophila* because of superficial appearance, behavior, and utilization of similar habitats (at least in Southeast Asia). Readily differentiated by having the costa unbroken; the subcostal vein complete, well separated from apex of vein R_1 ; lacking bristles in vibrissal row; second antennal segment with a dorsal bristle; and by having only two pairs of fronto-orbital bristles. The postocellar bristles are convergent or parallel. Third antennal segment variable in shape with arista plumose to bare. All tibiae with preapical dorsal bristles. Vein $Cu_1 + 1stA$ short, incomplete and cell M (2nd basal) and cubital cell short (fig. 54a).

The adults are found on vegetation, usually in heavy shade. The larvae are scavengers, breeding in rotting leaves and other vegetation.

Only the genus *Homoneura* van der Wulp is represented in Hawaii. Four species have been reported; only two are apparently established.

Genus **HOMONEURA** van der Wulp

Homoneura van der Wulp, 1891, Tijdschr. Ent. 34:213. Type-species, *picea* van der Wulp, by monotypy.

For synonymy refer to Shewell (1965:697).

This genus has been characterized by Malloch (1934:180) by having the costal fringe extending to apex of vein $R_4 + 5$; by having three pairs of postsutural and no presutural dorsocentral bristles; and by having a series of very short, closely placed black bristles on anterior half of the anteroventral surface of front femur (fig. 56b).

KEY TO SPECIES WHICH HAVE BEEN RECORDED FROM HAWAII

1. Wings hyaline or subhyaline. 2
 Wings marked with large brown spots (fig. 55a). . . .
 **striatifrons** (de Meijere).
2. Mostly or entirely rufous species. Postocellar
 bristles cruciate; arista plumose (fig. 56c). 3
 Brown, gray pollinose species. Postocellars parallel;
 arista pubescent, male genitalia as in figures 54c,
 d. **hawaiiensis** (Grimshaw).
3. Abdomen with rows of black spots.
 **postmacula** (Walker).

Entirely rufous species, male genitalia as in figures
56d, f. **unguiculata** (Kertész).

Homoneura hawaiiensis (Grimshaw) (figs. 54a-e)

Sciomyza hawaiiensis Grimshaw, 1902, Fauna Hawaiiensis 3:84. Type-locality: N.W. Koolau, Oahu.

Homoneura hawaiiensis Malloch, 1927, Proc. Haw. Ent. Soc. 6:383. Type-locality: Tantalus, Oahu.

Widespread over all the main islands.

Immigrant. Marquesas, Society Islands, Samoa, and Solomon Islands (Malloch, 1940a:143).

Habits: Scavengers, living in dead leaves. They have been bred from rotting leaves of *Acacia koa* Gray.

Body mostly brown with thorax densely gray pollinose and abdominal terga each with a yellow-gray band across apex. Frontal bristles evenly spaced, head shaped as in figure 54b. Arista pubescent. Postocellar bristles parallel. Three pairs postsutural dorsocentral bristles. A strong propleural bristle present just above front coxa. Legs entirely yellow. Wings hyaline, venation similar to that of *unguiculata*. Female with three rather elongate spermathecae, slightly over two times longer than wide. The male surstyli are short, thick, truncate apically, and serrated along the edge (fig. 54c). The aedeagus is short, thick, bulbous (fig. 54d).

Length: body, 3.7-4.0 mm.; wings, 3.3-3.5 mm.

Homoneura postmacula (Walker)

Chlorops postmacula Walker, 1849, List of spec. Dipt. Ins. Brit. Mus. 4:1121.

Chlorops postmaculata Becker, 1911, Annls. hist.-nat. Mus. natn. hung. 9:35.

Misspelling. Type-locality: "Sandwich Islands."

Oahu. Known only from the type, probably not established.

Immigrant. Probably Fiji Islands.

The type was studied by Sabrosky (1940:419) and found to be a Lauxaniidae. He later (pers. comm.) indicated that this was evidently a *Homoneura* fitting neither of the species recorded from Hawaii. We have recently asked Dr. Brian H. Cogan, British Museum (Natural History) to recheck the type to see if it might possibly be the same as *unguiculata* (Kertész). He found (pers. comm.) that these are distinct species and that *postmacula* appears to be conspecific with *Homoneura lissonata* (Bezzi) described from Fiji. "*H. postmacula* differs slightly, the black spots, one lateral pair and a single median linear black mark, are distinct from segment 3 onwards, instead of four as in *H. lissonata*. Although I have had no experience with Lauxaniids, I very much doubt whether the two species are distinct and the Bezzi name should fall."

From Walker's description this species would fit the characteristics of *unguiculata* except that the abdomen has three rows of black spots, most distinct towards the tip "where the spots on the middle row are oblong."

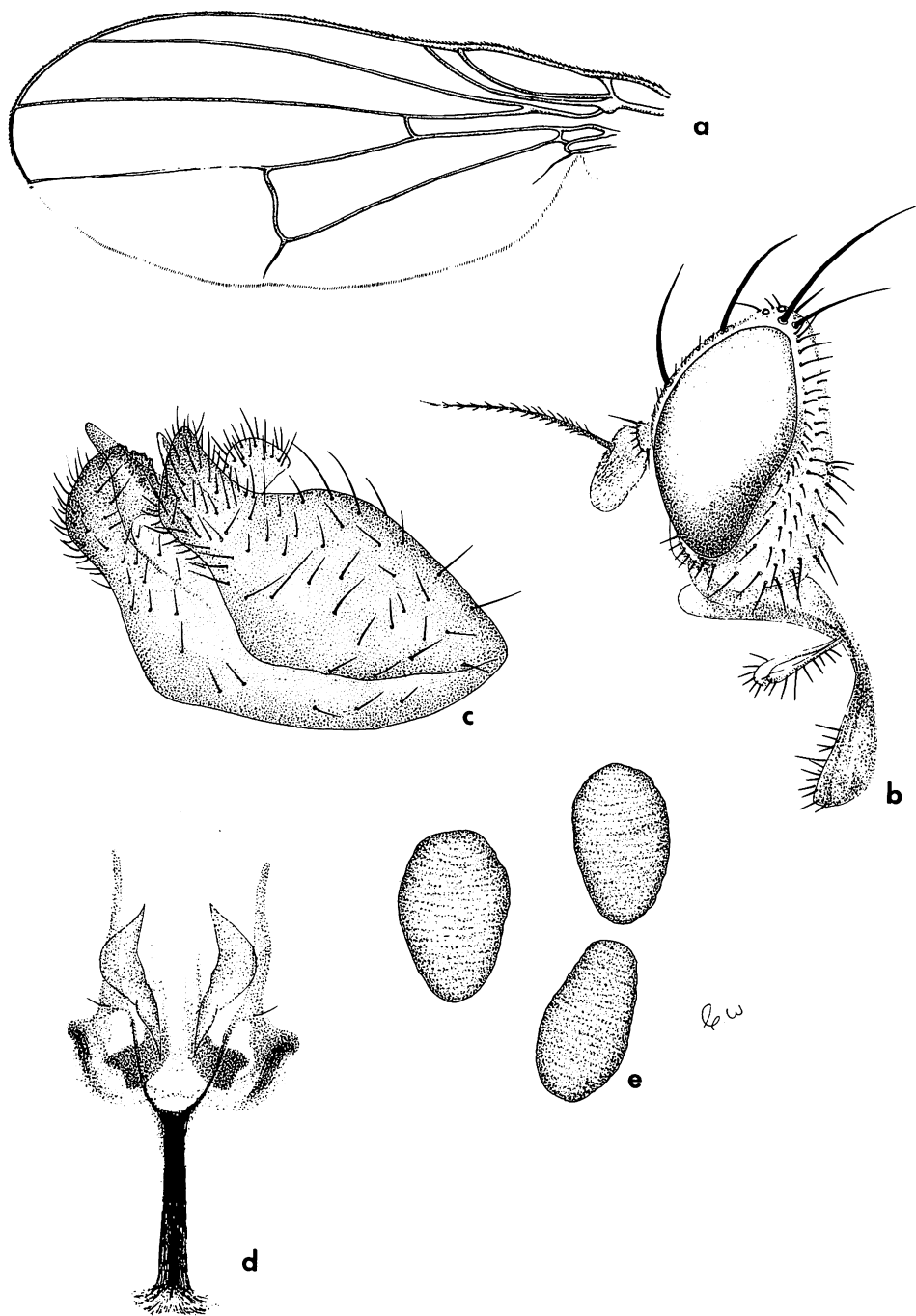


Figure 54—*Homoneura hawaiiensis* (Grimshaw): a, wing; b, head, lateral; c, male genitalia, lateral; d, aedeagus; e, spermathecae.

Homoneura striatifrons (de Meijere) (figs. 55a-b)

Lauxania striatifrons de Meijere, 1924, Tijdschr. Ent. 67, (Suppl.):52. Type-locality: Tjibodas, Java.

Maui. Known in Hawaii from only one specimen taken at Nahiku, January, 1908, no collector given.

Immigrant. Previously known only from Java.

The specimen at hand appears to fit this species. However, it is obviously a pale specimen and does not have the brownish black thoracic markings which were indicated in the original description. This species is apparently not established in the Hawaiian Islands. It is strikingly different from the Hawaiian *Homoneura* and is readily separated by the dark markings on the wings (fig. 55a), as well as by other details.

The following description is based upon the teneral male specimen at hand and may not be typical. A predominantly yellow-gray species with pale yellow-brown markings on thorax and on the apices of abdominal terga. Front yellow pollinose; a broad vertical, pale brown vitta extends down each side between orbits and the area bordering ocellar triangle. Two pairs of strong reclinate

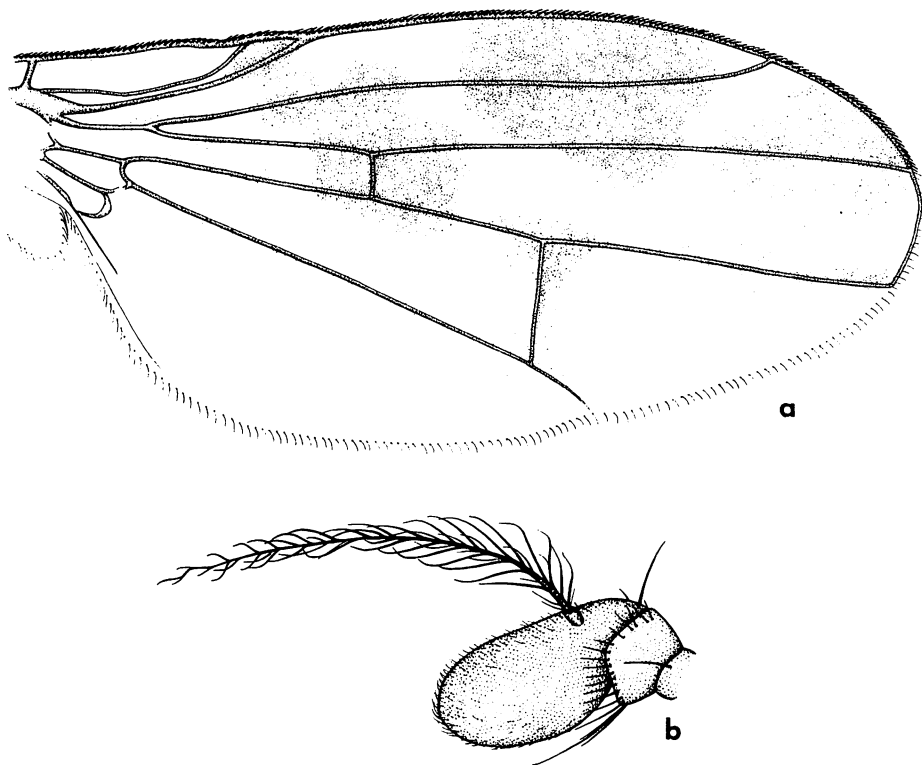


Figure 55—*Homoneura striatifrons* (de Meijere): a, wing; b, antenna.

bristles present on front. Occiput entirely pale yellow. Face predominantly yellow-white with a dark brown vitta down each side in line with vibrissal row of setae; also, a streak of brown extends across lower margin of face. Gena yellow-white with a narrow edge of brown along ventral margin. Oral vibrissae represented by short hairs; no distinct bristles are present in vibrissal row. Clypeus yellow, palpi and mouthparts rufous, tinged faintly with brown. Each palpus has a short apical bristle and numerous black setae around margin. Antennae rufous, third segment about 1.7 times longer than wide. Second antennal segment with a strong dorsal bristle. Arista moderately plumose (fig. 55b). Thorax predominantly yellow-gray pollinose with four pale yellow-brown vittae down mesonotum, the lateral vittae broadly interrupted at suture. According to the original description the type has four brownish-black vittae down mesonotum. Three pairs of strong dorsocentrals present, anterior pair situated just before suture. One strong pair of prescutellar acrostichal bristles present. Scutellum pale brown on disc, yellow on sides. Pleura entirely yellow in ground color, densely yellow-gray pollinose; there is no indication of longitudinal vittae but this may be partly obscured by the position of the microneedle through middle of thorax. According to the original description the type has three brown, longitudinal vittae extending through pleural region. Anterior sternopleural bristle nearly four-fifths as long as posterior bristle. One bristle is present on each humerus. Legs entirely yellow, tinged lightly with brown on femora. Front femur with a row of short, stout anteroventral spines extending over apical half of segment; four moderately strong posteroventral bristles and a row of eight or ten posterodorsal bristles are present. The preapical dorsal bristles are strong on all tibiae. Wings predominantly hyaline with conspicuous brown spots as in figure 55a. Brown spots are present over both crossveins; the spot over r-m extends obliquely to wing margin, reaching costa between subcostal vein and vein R_1 . A large brown spot is present near apical portion of cell R_1 ; this extends through cell R_3 and into upper portion of cell R_5 , at about the half way point between r-m crossvein and apex of wing. A large spot also present in apex of cell R_3 extending to cell R_5 into upper portion of cell 2nd M_2 , extending along vein $M_1 + 2$ about two-thirds the distance from wing margin to m crossvein. Another brown spot also present at base of wing. The costal fringe ends at apex of vein $R_4 + 5$. Third costal section (that section between the apices of vein R_1 and $R_2 + 3$) is three times longer than fourth costal section. The last section of vein $M_1 + 2$ two times longer than penultimate section. Abdomen yellow with narrow borders of brown at apices of terga. The genitalia have not been studied.

Length: body, 4 mm.; wings, 4.3 mm. In the original description de Meijere gave the body and wing length as 5.0 mm.

***Homoneura unguiculata* (Kertész) (figs. 56a-f)**

Lauxania unguiculata Kertész, 1913, Annls. hist.-nat. Mus. natn. hung. 11:100.

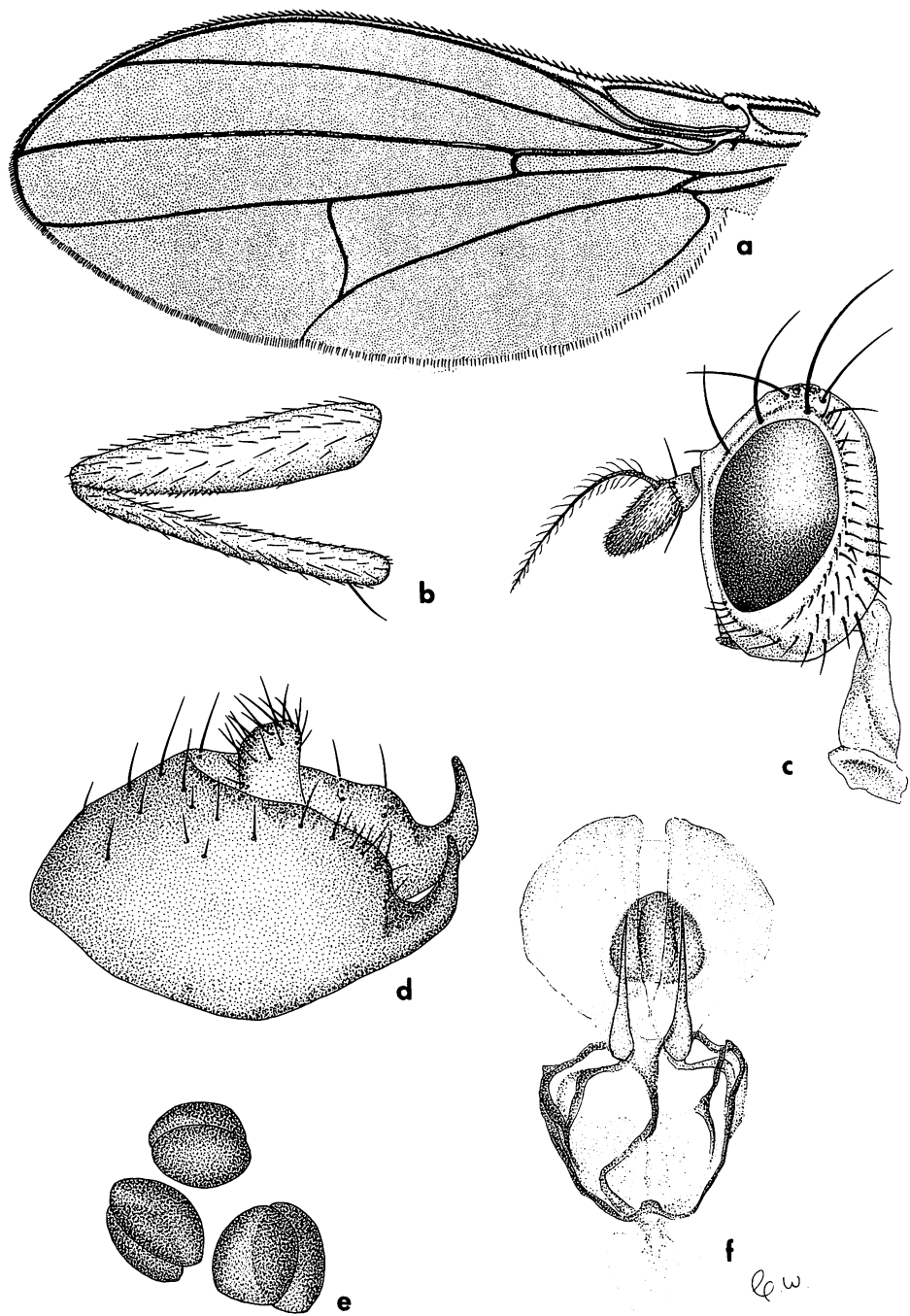


Figure 56—*Homoneura unguiculata* (Kertész): a, wing; b, front femur and tibia, anterior surface; c, head, lateral; d, male genitalia, lateral; e, spermathecae; f, aedeagus.

Widespread over all the main islands. First reported February, 1951 (Hardy, 1952:346). It obviously has been in Hawaii many years; we have seen specimens collected in 1920 and this is no doubt the species referred to by Grimshaw (1902:5) as *Sapromyza* sp. from "the Honolulu Mts., 1900."

Immigrant. Formosa, Ceylon, Canton, Okinawa, Florida, South Carolina, and Hawaii (ref. Shewell, 1966).

Scavengers, breeding in rotting vegetation. They have been reared from rotting leaves of *Cordyline terminalis* (L.), "Ti."

Yellow to rufous species superficially resembling some of the introduced ("garbage can") species of *Drosophila* because of size, general facies, and color. Readily differentiated from *hawaiiensis* by the color; the cruciate postocellar bristles; the wings faintly yellowish tinged; the plumose arista; and the striking differences in the male genitalia (figs. 54c, d and 56d, f) and the female spermathecae (figs. 54e, 56e).

Head as in figure 56c. Wing as in figure 56a. Surstyli of male curved sharply upward, slender pointed, hook-like, visible *in situ*. The aedeagus is large, fleshy, and divided into two lobes (fig. 56f). Three round spermathecae in female (fig. 56e).

Length: body, 2.75–3.2 mm.; wings, 2.6–3.0 mm.

Family SPHAEROCERIDAE

The members of the family Sphaeroceridae are basically scavengers both in the larval and adult stages. The family is characterized by having the hind basitarsi shortened and incrassate, and the wing (with the exception of a few genera, *i.e.*, *Copromyza* in Hawaii) with $M_1 + 2$ and $M_3 + Cu_1$ evanescent, 2nd basal cell confluent with discal cell, anal vein very faint, subcosta faintly developed, and costa with two breaks. The adults are frequently found in association with excrement of various mammals especially cattle, horses, and sheep. The feces of dog, cat, chicken, wild animals, and man are also breeding and feeding sites of these flies. Hammer (1941) and Laurence (1954, 1955) presented ecological and biological studies of some British Sphaeroceridae in association with cattle and cattle manure. In addition to excrement, these flies have been bred by Richards (1930) from fungi, dead animals, ant and wasp nests, and decaying plants of various sorts. Tenorio (1968) provided the first biological information on the species that occur in Hawaii. He reared one species from seaweed and many other species from cattle and horse manure, and presented a synopsis of rearing and habitat records for most of the species. According to Tenorio (1968), all of the species reared have a short life cycle, an average of about 12 days from egg to adult. The ornamentations on the eggs, in the form of reticulations and projections or processes, are distinct for each species. The larval and pupal characters are not as striking as in the eggs, but

This section on the Sphaeroceridae was prepared by Joaquin and Joann M. Tenorio.

some specific characters are manifested in mouth-hooks, spiracles, and body hooks.

Grimshaw (1901) described two species, one of which later was shown to be a junior synonym (Richards, 1952:429), and recorded one other species. Subsequent works on the Hawaiian fauna included those of Bryan (1934), Richards (1952, 1965), Hardy (1952), and most recently Tenorio (1967, 1968). These studies brought the total number of Sphaeroceridae in Hawaii to 22 species. Many of these species appear widespread, having representatives in the Holarctic, Neotropical, and Ethiopian regions as well as the South Pacific; some are cosmopolitan. Only two of the species described to date are known to occur only in Hawaii; it is likely that both of these species may subsequently be recorded from other areas. Of the Hawaiian species, four are found only on Oahu, one found only on Maui (Haleakala), and the remainder are fairly well distributed throughout the six major Hawaiian Islands. That four species of almost worldwide distribution are found only on Oahu probably reflects the fact that Oahu has been more thoroughly collected than any of the other major islands. It is our estimation that the five species which are now known only from one island probably occur on other islands also.

Most of the information and keys presented in this section have been modified and adapted from Tenorio (1968).

KEY TO GENERA OF SPHAEROCERIDAE KNOWN FROM HAWAII

Veins $M_1 + 2$ and $M_3 + 4$ both evanescent, never fully pigmented much beyond m crossvein; anal cell absent, anal vein only faintly visible; hind tibia lacking ventral apical curved spur; propleura not hairy. **Leptocera** Olivier.

Vein $M_1 + 2$ always reaching the margin of the wing and completely pigmented; anal cell and anal vein present; hind tibia with ventral apical curved spur (fig. 57b); propleura hairy. **Copromyza** Fallén.

Genus **COPROMYZA** Fallén

Copromyza Fallén, 1810, Specim. entomolog. nov. Dipt.:19. Type-species, *Copromyza equina* Fallén, by subsequent designation of Zetterstedt (1847:2475).
Borborus, subg. *Trichiaspis* Duda, 1923, Arch. Naturgesch. (A) 89(4):55.
Borborus, authors, not Meigen.
Cypsela, authors, not Meigen.

This genus was originally proposed without included species. Fallén (1820) included seven species from which Zetterstedt (1847) designated *C. equina* Fallén as the type (Richards, 1930:263).

The genus *Copromyza* has vein $M_1 + 2$ always reaching the margin of the wing

and completely pigmented, the anal cell and anal vein present, the hind tibia with a ventral apical curved spur (fig. 57b), and the propleura hairy.

Only two species occur in Hawaii.

KEY TO SUBGENERA AND SPECIES OF *COPROMYZA* KNOWN FROM HAWAII

Face, genae, and frons dark gray to black; genae ventrally with a tomentous area, one half as high as gena between the eye and buccal margin and extending from the vibrissa to about posterior one-fourth of gena. Thorax with two grayish vittae just inside the dorsocentral lines. Sternopleura shining black, mesopleura and scutellum dull gray. Hind tibia lacking the anterior apical bristles; 2nd tarsomere slender. Body length less than 3 mm. (***Borborillus***) ***sordida*** (Zetterstedt).

Face, genae, and anterior margin of frons, yellowish to reddish. Thorax with sternopleura, three-fourths of mesopleura, and scutellum shining black. Hind tibia with an anterior apical bristle about one-half as long as the ventral apical curved spur (fig. 57b); second tarsomere about as broad as basitarsus. Body length greater than 3 mm. (***Copromyza***) ***equina*** Fallén.

Subgenus **COPROMYZA** Fallén

This subgenus is characterized by having the scutellum with fine hairs in addition to four marginal bristles; the hind tibia without an anteroventral bristle at apical one-third; and the male front basitarsus lacking a ventral hook at apex.

***Copromyza* (*Copromyza*) *equina* Fallén** (figs. 57a, b, 66a)

Copromyza equina Fallén, 1820, *Heteromyzides* Sveciae:6. Type-locality: Sweden.

Found on Hawaii, Maui, Molokai, Kauai, and Kahoolawe.

Immigrant. Europe, North America.

First reported by Wirth (1947:22) from Hawaiian Islands; no definite island given. Richards (1952:429) recorded this species from Hawaii at Lake Waiau (13,007 ft. near top of Mauna Kea).

This species has been reared from horse manure and collected from a banana bait trap; it seems to prefer higher elevations. *C. equina* has not yet been collected on Oahu.

Sternopleura shining black, except for a narrow strip along the dorsal

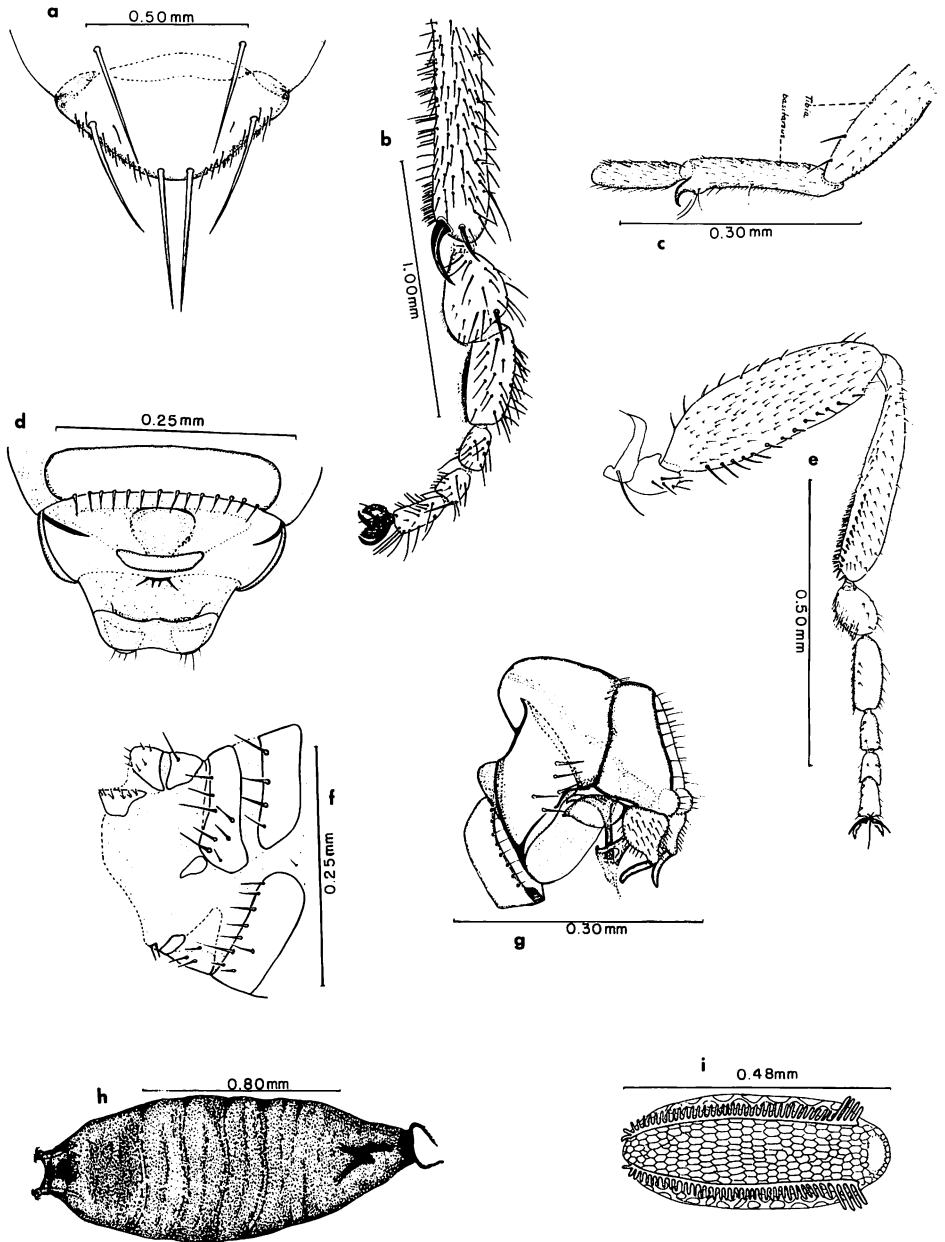


Figure 57—*Copromyza equina* Fallén: a, scutellum; b, hind tibia and tarsus, anterior. *C. sordida* Zetterstedt; c, front basitarsus, posterior. *Leptocera bifrons* (Stenhammar): d, female genitalia, ventral; e, hind leg of male, anterior; f, female genitalia, lateral; g, male genitalia, lateral; h, pupa, ventral; i, egg, dorsal.

margin. Mesopleura with the dorsal and the posterior fourth dull, the rest shining black like the sternopleura. Propleura uniformly hairy, without distinct long bristle-like hairs. Margin of scutellum with several long hairs in addition to four marginal bristles. Scutellum shining. Body length about 3.9 mm. Male right clasper (fig. 66a).

Subgenus **BORBORILLUS** Duda

Borborus, subg. *Borborillus* Duda, 1923, Arch. Naturgesch. (A) 89(4):54. Type-species, *Borborus uncinatus* Duda, by subsequent designation of Richards (1930:267).

This subgenus has the scutellum with four marginal bristles, but without marginal hairs; the hind tibia with an anteroventral bristle at about apical one-third; and the male front basitarsus with a ventral hook at the apex (fig. 57c).

Copromyza (Borborillus) sordida Zetterstedt (figs. 57c, 66b)

Copromyza sordida Zetterstedt, 1847, Dipt. Scand. 6:2484. Type-locality: Sweden.

Borborus bilineatus Grimshaw, 1901, Fauna Hawaiiensis 3:75. Type-locality: Kona, Hawaii.

For a more complete synonymy see Richards (1962).

Found on Hawaii, Maui, Molokai, Oahu, and Kauai. First described by Grimshaw (1901) from Kona, Hawaii as *Borborus bilineatus* and subsequently synonymized by Richards (1952:429).

Immigrant. Europe, Africa, Canary Is., North America, India, Bermuda. Originally described from Sweden.

A male and female emerged from horse manure and were subsequently found to be infested with nematodes when attempts were made to rear them. Other specimens have been taken from horse and cattle manure and light traps.

Sternopleura shining beneath, mesopleura dull gray except for a small area along the anteroventral corner. Propleura with one long bristle in addition to the small hairs. Thorax with a pair of gray lines between the dorsocentral lines. Scutellum dull, with four marginal bristles, lacking hairs. Male right clasper (fig. 66b).

Genus **LEPTOCERA** Olivier

Leptocera Olivier, 1813, Mem. Soc. Cent. Agric. Dept. Seine et Oise 16:489.

Type-species, *nigra* Olivier, by monotypy.

Limosina, subg. *Paracollinella* Duda, 1924, Verh. zool.-bot. Ges. Wien. (1923) 73:166. Type-species, *Copromyza fontinalis* Fallén, by designation of Richards, 1930:267.

The names *Leptocera* Olivier and *Limosina* Macquart have been in a state of confusion since 1928.

Richards (1930), in his paper on British Sphaeroceridae, placed *Limosina* Macquart as a subgenus of *Leptocera* Olivier. Richards (1952) elevated *Limosina* Macquart to a generic position replacing *Leptocera*, following Duda (1938:14) who claimed that "*Leptocera* Olivier, 1813, was founded on a species of chloropid" (Richards, 1952:429). However, Duda's claim was contested by C. W. Sabrosky, Chloropidae specialist with USDA at the U.S. National Museum, Washington (Richards, 1956); and consequently Richards proposed that *Leptocera* Olivier should be retained as the valid genus. This is the present status.

Leptocera is represented in Hawaii by twenty species arranged in nine subgenera. The majority of the species are found on or about cow manure.

This genus can be separated from *Copromyza* by the absence of the anal vein and anal cell, $M_1 + 2$ never reaching the wing margin and never much beyond m crossvein, the propleura bare or sometimes with one or two minute hairs, and the hind tibia lacking a ventral curved apical bristle.

KEY TO THE SUBGENERA AND SPECIES OF LEPTOCERA KNOWN FROM HAWAII

1. Disc of scutellum completely covered with relatively uniform short bristles (fig. 65c). Costa always extending beyond the apex of $R_4 + 5$ (fig. 65a). (**Coproica**) 17
- Disc of scutellum never completely covered with short bristles. Costa varied. 2
- 2(1). Frons and mesonotum with whitish spots. Wing with dark areas at apex of R, on R opposite base of $R_4 + 5$, apex of $R_2 + 3$, and base of $R_4 + 5$. $R_4 + 5$ curved forward, $M_1 + 2$ weakly sinuate. Legs brown-banded. (**Poecilosomella**).
- **punctipennis** (Wiedemann).
- Frons and mesonotum lacking whitish spots. Wing without dark spots on veins, and legs not banded. 3
- 3(2). Middle tibia with distinct ventral apical bristles; middle basitarsus lacking ventral bristle near base. 6
- Middle tibia without ventral apical bristle; preapical ventral bristle usually present; middle basitarsus with distinct ventral bristle near base. 4
- 4(3). Scutellum with more than four marginal bristles. Middle trochanter with long upcurved ventral bristle. Middle tibia with a preapical ventral bristle. 5

- Scutellum with only four marginal bristles. Middle trochanter lacking a long upcurved ventral bristle. Middle tibia without a preapical ventral bristle. Middle basitarsus with a ventral bristle near the base. Apex of $M_1 + 2$ slightly bent backward. Frons and antennae black. Male with rows of comb-like ventral bristles on basal half of middle femur and apical half of middle tibia. (**Opacifrons**) **aequalis** (Grimshaw).
- 5(4). Disc of scutellum with small bristles, a pair of long bristles also present. Anterior pair of dorsocentral bristles directed inward. Male middle femur with a short but strong ventral bristle near the base. (**Rachispoda**) **downesi** Richards.
Disc of scutellum lacking bristles (with eight marginal bristles, the anterior pair hair-like); anterior pair of dorsocentrals not directed inward. Male middle femur without the ventral bristle near the base. (**Leptocera**) **abdominiseta** Duda.
- 6(3). Frons with only one pair of interfrontal bristles. Middle basitarsus thickened. Wing with short bristles on first costal sector; posterior corner of discal cell rounded; anal vein (faintly visible) rounded posteriorly. Male middle tibia with a group of ventral bristles. (**Pachytarsella**)
. **pachypus** Richards.
Frons always with more than one pair of interfrontal bristles. Middle basitarsus not thickened. Posterior corner of discal cell not rounded. 7
- 7(6). Dorsocentral bristles in more than two pairs, the two anterior pairs directed inward. Antennae divergent and widely separated, the distance between their bases about equal to one antennal length. Eyes relatively small, oval, appearing granulated. Small brown species (0.9–1.2 mm.) breeding in seaweed. (**Thoracochaeta**)
. **brachystoma** (Stenhammar).
Dorsocentral bristles in not more than two pairs. Antennae and eyes varied. 8
- 8(7). Frons always with a row of small bristles about midway between the interfrontal and orbital bristles (fig. 62a). $R_4 + 5$ extremely curved forward thus meeting the costa much before the apex of wing;

- costa continuing considerably beyond apex of $R_4 + 5$. Very small species with small eyes, which are sometimes hairy. (**Trachyopella**) 15
- Frons lacking the row of bristles midway between the interfrontal and orbital bristles. $R_4 + 5$ not extremely curved forward. Costa not continuing considerably beyond the apex of $R_4 + 5$. (**Limosina**) 9
- 9(8). Hind tibia with long curved ventral bristle arising just beyond the middle (fig. 59f). $R_4 + 5$ meeting the costa very close to the wing apex. Female cerci each with a dorsal black bristle (fig. 59i). Small black species. **mirabilis** (Collin).
Hind tibia lacking long curved ventral bristle.
Female cerci without dorsal black bristles. 10
- 10(9). Vein $R_4 + 5$ curved forward. 11
Vein $R_4 + 5$ straight, at most apex bent forward. 13
- 11(10). Vein $R_2 + 3$ short, its length less than half the length of $R_4 + 5$; sometimes sinuate apically. Second costal sector scarcely half the length of the third sector. Male middle tibia at apical third with irregular rows of comb-like bristles. Female middle tibia relatively bare on posterior face. Wings fumose. **brevivenosa** Tenorio.
Vein $R_2 + 3$ more than half as long as $R_4 + 5$. Second costal sector longer than half the length of third sector. Middle tibiae of male and female not modified as above. 12
- 12(11). Male fifth abdominal sternum bordered posteriorly with black, spine-like, closely placed bristles arranged like a comb (fig. 58a); these bristles extend along the entire posterior margin. Male clasper as in figure 67e. **brevicostata** (Duda).
Male fifth abdominal sternum bordered by two separate rows of minute comb-like bristles which do not extend along the entire posterior margin (fig. 60c). **rufifrons** Duda.
- 13(10). Hind femur with a preapical dorsal bristle. Eyes relatively small, longest diameter less than half the height of head. Vibrissal angle with one long and one short bristle; one moderately long jowlar bristle, about three-fourths as long as longest vibrissa, directed anterodorsal. Male middle

femur basally with tuft of ventral bristles; tibia at apical half with irregular rows of comb-like ventral bristles. **empirica** (Hutton).

Hind femur lacking preapical dorsal bristle. Longest diameter of eyes more than half the height of head. One vibrissal bristle; jowlar bristles weak. Male middle femur and tibia not modified as above. 14

- 14(13). Crossveins r-m and m situated very close together, distance between them less than half length of m. $R_4 + 5$ bent forward at apex and overpassed a short distance by the costa. Frons uniformly brown to dark brown **heteroneura** (Haliday).

Crossveins r-m and m situated farther apart than half the length of m. $R_4 + 5$ straight, scarcely overpassed by the costa. Frons yellow anteriorly, dark posteriorly. Male hind femur with a row of ventral bristles on basal half; tibia with irregular rows of comb-like ventral bristles on apical half (fig. 57e). **bifrons** (Stenhammar).

- 15(8). Eyes hairy (fig. 62a). $R_2 + 3$ strongly bent forward at base of fork; length about a third the length of $R_4 + 5$. Second costal sector scarcely two-thirds the length of the third sector. Hind tibia lacking preapical dorsal bristle. **atomus** (Rondani).

Eyes bare. $R_2 + 3$ not strongly bent forward, either running almost parallel to, or very close to, the costa. Second costal sector longer or only slightly shorter than third sector. Hind tibia with a preapical dorsal bristle. 16

- 16(15). Wing with $R_2 + 3$ arched and running extremely close to costa; apex of $R_2 + 3$ not bent or curved forward, gradually approaching the costa, running very close to the costa for a short distance. Second costal sector as long as or shorter than third sector. Thorax with two rows of acrostichals between the two posterior dorsocentral bristles. **hardyi** Tenorio.

Vein $R_2 + 3$ running almost parallel to costa, but not very close to it; apex of $R_2 + 3$ bent forward. Second costal sector as long as or longer than third sector. Thorax with three or more rows of acrostichals between the two posterior pairs of dorsocentral bristles. **obliqua** Richards.

- 17(1). Second costal sector scarcely as long as third sector (fig. 65d). Frons anterior margin red-brown, vertex black. Section of costa overpassing apex of $R_4 + 5$ more than half the length of first section of $R_4 + 5$ **hirtula** (Rondani).
 Second sector of costa distinctly longer than third sector (fig. 65a). 18
- 18(17). Thorax reddish brown. Sternopleura with three bristles. First costal sector with relatively long bristles (fig. 65a). **ferruginata** (Stenhammar).
 Thorax dark or black. Sternopleura with only two bristles. First costal sector with short bristles. 19
- 19(18). Sternopleural bristles small, about half as long as the backwardly directed humeral bristle. $R_4 + 5$ beyond r-m crossvein straight. Male with front basitarsus enlarged apically; hind basitarsus prolonged ventroapically into a blunt spine-like projection; wing vein $M_1 + 2$ strongly bent posteriorly and forming a more or less straight line with m crossvein, the margin opposite the apex of the discal cell with a row of long upcurved bristles. **acutangula** (Zetterstedt).
 Sternopleura with two almost equally long bristles, widely spaced. $R_4 + 5$ slightly curved forward; costa ending before the apex of the wing. Male with front and hind basitarsi and wings not modified. **vagans** (Haliday).

Subgenus **COPROICA** Rondani

Heteroptera Macquart, 1835, Hist. nat. Ins. 2:570 (preocc. Rafinesque, 1814).
 Type-species, *Limosina pusilla* Meigen, by monotypy, misidentification, = *acutangula* Zetterstedt.

Coproica Rondani, 1861, Dipterol. ital. Prodr. 4:10 (as genus, new name for *Heteroptera* Macquart). Type-species, *Borborus pusillus* Meigen, by monotypy; misidentification, = *Limosina acutangula* Zetterstedt.

Limosina, subg. *Coprophila* Duda, 1918, Abh. zool.-bot. Ges. Wien 10(1):45.
 Type-species, *Borborus vagans* Haliday, by designation of Spuler, 1925b:122.

This subgenus is characterized by having the scutellar disc uniformly covered by short bristles (fig. 65c).

Leptocera (Coproica) acutangula (Zetterstedt) (fig. 69b)

Limosina acutangula Zetterstedt, 1847, Dipt. Scand. 6:2499. Type-locality: Sweden.

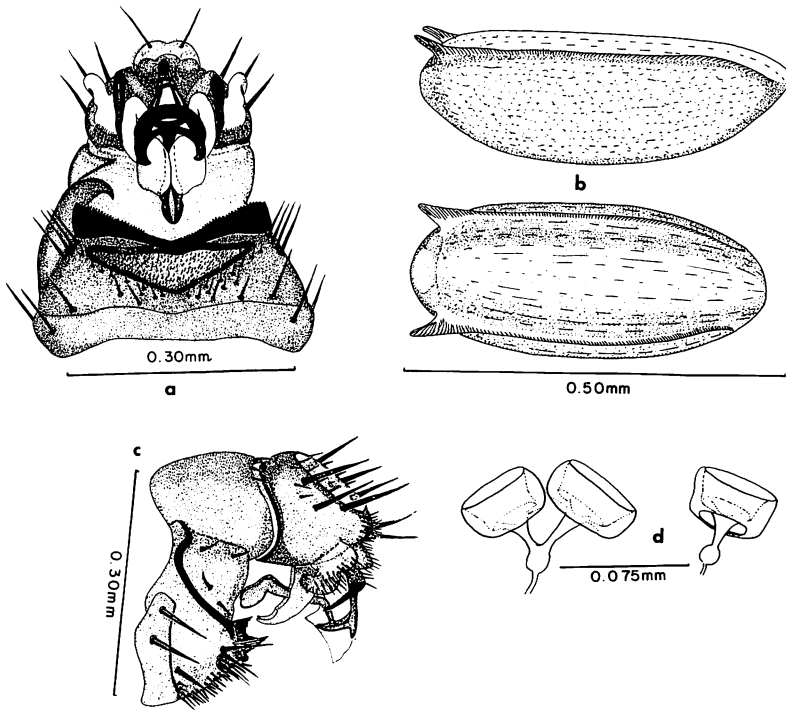


Figure 58—*Leptocera brevicostata* (Duda): a, male genitalia, ventral; b, eggs, lateral and dorsal; c, male genitalia, lateral; d, spermathecae.

First reported from Oahu by Tenorio (1968). One additional specimen has been collected on Kauai, Nawiliwili Dock, 14 July 1968 (J. A. Tenorio); this is a new distribution record for this species.

Immigrant. Europe, Madeira, Africa, North America. First described from Sweden.

A long series of both sexes was reared from horse manure by Tenorio (1968).

The female of this species is very similar to that of *L. vagans* (Haliday). The male, however, can be easily recognized by the presence of upcurved hairs on the posterior margin of the wing toward the apex. Male clasper as in figure 69b.

***Leptocera (Coproica) ferruginata* (Stenhammar) (figs. 65a-c, 69c)**

Limosina ferruginata Stenhammar, 1854, Kongl. Vet.-Akad. Handl.:397.

Type-locality: Sweden.

References: Richards, 1952:431; 1963:132.

First reported, from Oahu by Bryan (1923b:292), as very common about refuse and manure. Not yet collected on other Islands.

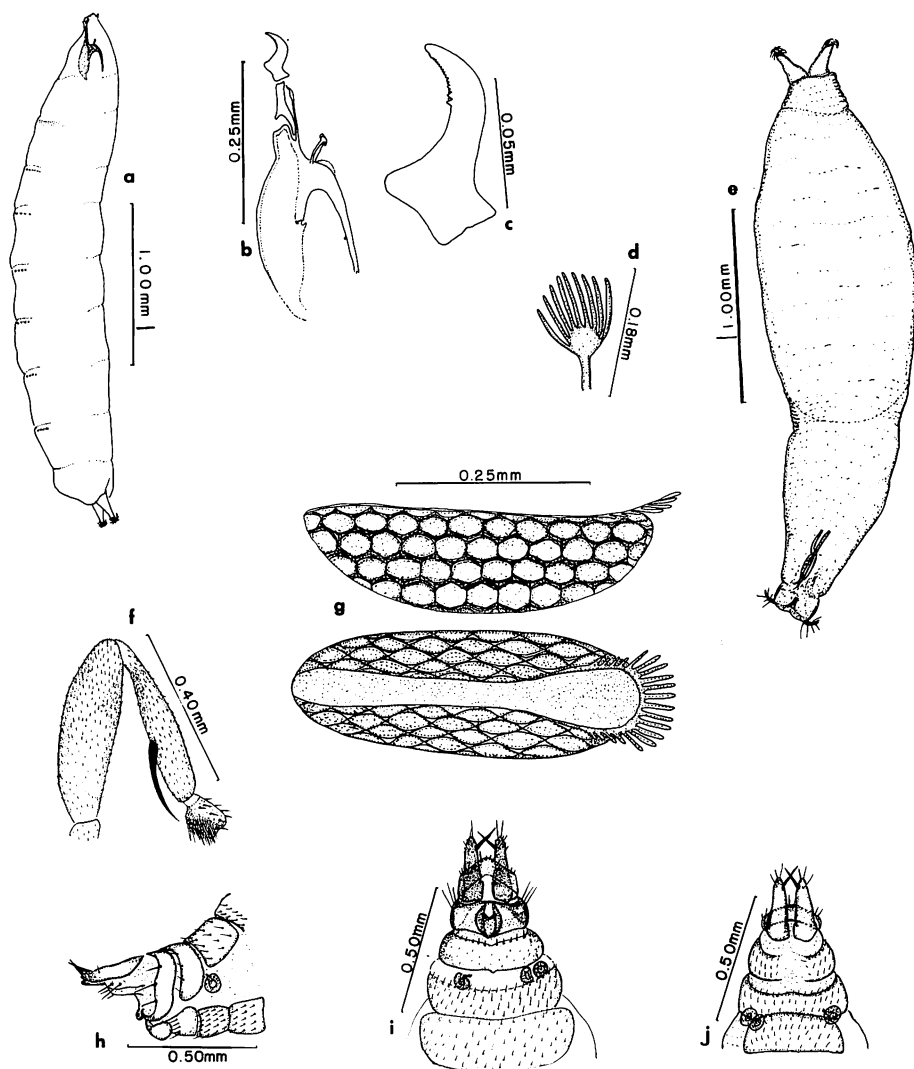


Figure 59—*Leptocera mirabilis* (Collin): a, last instar larva, lateral; b, cephalopharyngeal skeleton of larva; c, mouth hook; d, anterior spiracle of larva; e, pupa, dorsal; f, hind leg, anterior; g, eggs, lateral and dorsal; h, female genitalia, lateral; i, female genitalia, ventral; j, female genitalia, dorsal.

Immigrant. Cosmopolitan. Originally described from Sweden.

This species has been reared from cow manure and found in association in manure piles with *L. vagans* (Haliday) and *L. hirtula* (Rondani).

L. ferruginata, as the name implies, is a predominantly reddish-brown species with the first costal sector with relatively long bristles (fig. 65a). Male clasper as in figure 69c. Female genitalia as in figure 65b.

Leptocera (Coproica) hirtula (Rondani) (figs. 65d, 69d)

Limosina hirtula Rondani, 1880, Dipterol. ital. Prodr. 8(25):24. Type-locality: Italy.

References: Richards, 1952:431; 1956:135; 1963:133.

For synonyms see Stone et al., 1965:725.

First reported from Oahu by Richards (1952) and since reported from Hawaii, Molokai, and Kauai, and several of the leeward islands (Tenorio, 1968).

Immigrant. Cosmopolitan. Originally described from Italy.

Predominantly black species with the anterior margin of frons orange to red-brown. Humeral callus with three bristles, the longest one directed posteriorly. First costal sector of wing with short bristles. Second costal sector more or less shorter than the third (fig. 65d). Costa overpassing $R_4 + 5$, this portion of costa more than one half as long as basal section of $R_4 + 5$. Veins $R_2 + 3$ and $R_4 + 5$ distinctly curved forward. Middle tibia with a preapical and a shorter apical bristle. Middle basitarsus with a ventral bristle near the base and a longer anteroventral bristle slightly beyond the middle. Right clasper of male (fig. 69d).

Leptocera (Coproica) vagans (Haliday) (fig. 69e)

Borborus vagans Haliday, 1833, Ent. Mag. Lond. 1:178. Type-locality: Ireland.

References: Richards, 1956:135; 1963:133.

First reported by Tenorio (1968) from Oahu.

Immigrant. Cosmopolitan. Originally described from Ireland.

Predominantly dark or black species. Frons black, with areas at base of frontal bristles usually brown or lighter than most of the frons. Antennae and face red-brown. Thorax with four humeral bristles, two are minute. Two sternopleural bristles about equally long and widely spaced. Wing with a pair of rather long bristles at the base of the costa. First costal sector with short bristles. Second costal sector distinctly longer than the third. Costa overpassing $R_4 + 5$, this section of costa half or less than half the length of basal section of $R_4 + 5$. Male clasper as in figure 69e.

L. vagans is relatively abundant in cow manure in association with *L. ferruginata* and *L. hirtula*, the latter two species occurring in fewer numbers than *vagans*. This species has been reared on cow manure in the laboratory, and the life cycle is estimated to take approximately sixteen days.

Subgenus LEPTOCERA Olivier

This subgenus has the middle tibia without an apical ventral bristle, the scutellum lacking bristles on the disc, but with 4 pairs of marginal scutellar bristles, and the anterior pair of dorsocentral bristles not directed inward.

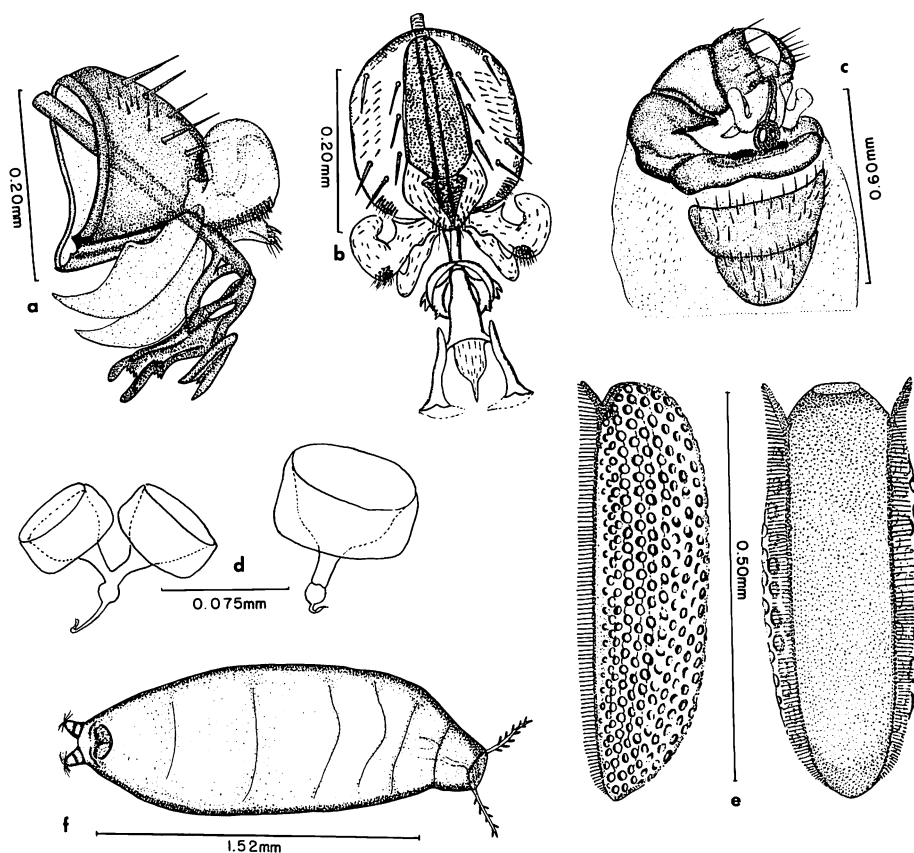


Figure 60—*Leptocera rufifrons* Duda: a, male genitalia, lateral; b, genitalia, end view; c, posterior portion of male abdomen, lateroventral; d, spermathecae; e, eggs, lateral and dorsal; f, pupa, ventral.

***Leptocera (Leptocera) abdominiseta* Duda (fig. 66c)**

Leptocera (Paracollinella) abdominiseta Duda, 1925, Arch. Naturgesch. (A) 90(11):52. Type-locality: South America.

References: Richards, 1952:430; 1956:135.

This species appears widespread on the six major islands.

Immigrant. South America.

Both males and females have been taken from light traps, bait traps, cow manure, and leaf litter in woods.

Head: Anterior half of frons reddish, vertex brown to black. Interfrontal line gray pollinose. Face yellowish, concave below the antennae. Genae yellowish. Antennae reddish to dark brown. Vibrissa angle with one long bristle, the longest jowler bristle about half as long as the vibrissal bristle. **Thorax:** Humeral callus with one long backwardly directed and two short inwardly

directed bristles. Sternopleura with two bristles, the anterior about a third as long as the posterior one. Scutellum with disc bare, margin with eight bristles, the anterior pair hair-like. Middle trochanter apically with a ventral upcurved bristle, tibia with a mid-ventral and a preapical ventral bristle, basitarsus with a ventral bristle near the base. *Abdomen*: Black. Apical corners of fifth and sixth segments appear hairy. Right clasper of male as in figure 66c.

Subgenus **LIMOSINA** Macquart

Limosina Macquart, 1835, Hist. nat. Ins. 2:571 (as genus). Type-species, *Borborus silvaticus* Meigen, by subsequent designation of Westwood, 1840:145.

Limosina, subg. *Scotophilella* Duda, 1918, Abh. zool.-bot. Ges. Wien. 10(1):34, 104. Type-species, *Borborus silvaticus* Meigen, by designation of Duda (1924c:6).

Leptocera, subg. *Spelobia* Spuler, 1923, Proc. Phil. Acad. Nat. Sci. 75:376. Type-species, *Limosina tenebraum* Aldrich, by original designation.

Leptocera, subg. *Americaptilotus* Richards, 1951, Brit. Mus. (Nat. Hist.) Ruwen-zori Exped. 2:845. Type-species, *Aptilotus borealis* Malloch, by original designation.

Aptilotus, Amer. Authors, not Mik.

This subgenus is better represented in Hawaii than any other, containing seven species.

Leptocera (Limosina) bifrons (Stenhammar) (figs. 57d-i, 67d)

Limosina bifrons Stenhammar, 1854, Kongl. Vet.-Akad. Handl.:401. Type-locality: Sweden.

References: Richards, 1952:429; 1956:135.

Found on Hawaii, Maui, Molokai, Oahu, and Kauai. This species was first recorded from Oahu by Richards (1952).

Immigrant. Europe, South Africa, Seychelles, Canary Islands, the Azores, Philippines, Samoa.

Duda (1918:154) used the name *Limosina puerula* and listed *bifrons*, of Rondani and of Stenhammar, as synonyms. Subsequently, Duda (1938) reverted to *Limosina bifrons* Stenhammar as valid name and synonymized *L. puerula*. Present status is as used in combination of Duda (1938:111) and Richards (1956:135).

Light brown, sometimes yellowish species. *Head*: Anterior margin of frons yellowish, sometimes red-brown, posterior two-thirds brown to black. Face shining brown, sinuate in profile. Genae yellow. Antennae with the first and second segments yellow to orange; third segment dark brown, hemispherical, with short pale pubescence, less than a fifth the length of the short pubescent arista. One long vibrissal bristle, jowler bristles all short. *Thorax*: Humeral callus with two bristles, inner one directed inward, outer directed backward.

One pair of long dorsocentral bristles, about as long as the anterior marginal scutellar bristle. Sternopleura with two hair-like bristles. Front legs yellow, middle and hind legs brown, middle coxa black, middle trochanter with a relatively long anterior apical bristle, middle tibia with an anterior apical bristle in addition to the longer ventral apical one. Female hind tibia with a short, but stout, ventral apical bristle. Male hind tibia (fig. 57e) ventrally with more or less paired rows of comb-like bristles on the apical half, femur with a single row of longer ventral bristles on the basal half. Wings hyaline. First costal sector with relatively long bristles. Second costal sector shorter than third. $R_2 + 3$ curved forward at apex. $R_4 + 5$ straight or slightly sinuate. Abdomen black. Genitalia as in figures 57d, f, g, and male clasper as in figure 67d.

This species has been found in leaf litter as well as in cow, chicken, and horse manure. In November 1966, it was observed in large numbers on cow manure and in less abundance on horse manure. It has been reared from cow manure in the laboratory. Eggs hatched in 12 to 24 hours; complete development of the larva took from 4 to 6 days; the pupal stage lasted from 3 to 5 days. Complete life cycle, egg to adult, required from 8 to 12 days.

Sizes of immature stages: egg, 0.48 mm. long, 0.33 mm. wide; pupa, 1.86 mm. long, 0.59 mm. wide.

Leptocera (*Limosina*) brevicostata (Duda) (figs. 58a-d, 67e)

Limosina (*Scotophilella*) *brevicostata* Duda, 1918, Abh. zool.-bot. Ges. Wien 10(1):183. Type-locality: Abyssinia.

Leptocera (*Limosina*) *pectinata* Tenorio, 1968, Proc. Haw. Ent. Soc. 20:187. Type-locality: Oahu. **New synonymy.**

This species was first reported from Oahu as a new species (Tenorio, 1968). Specimens identified as *L. brevicostata* were subsequently received from Dr. W. Hackman, Zoological Museum of the University, Helsinki, and the genitalia of the males were dissected. From these dissections it is evident that the male genitalia of *L. pectinata* Tenorio and *L. brevicostata* (Duda) are identical. We are thus citing *pectinata* as a junior synonym of *brevicostata*.

Found on Hawaii, Maui, Molokai, Oahu, and Kauai.

Immigrant. First described from Abyssinia (Ethiopia). Widely distributed: Europe, Africa, the Canary Islands, the Azores, Madeira.

Closely resembling *rufifrons* Duda and differentiated by the setation of the male fifth abdominal sternum and the male claspers. The fifth abdominal sternum has comb-like spines directed posterodorsally along the posterior margin; spines are longest laterally and gradually decrease in length medianly (fig. 58a). Clasper with one strong black spine directed anteriorly from lateral view (fig. 67e) and with a clump of hairs on the lobe lateral to the spine.

The female of this species is difficult to distinguish from the female of *rufifrons*.

The eggs of *brevicostata* (fig. 58b) were found to be distinct from the eggs of *rufifrons* (fig. 60e).

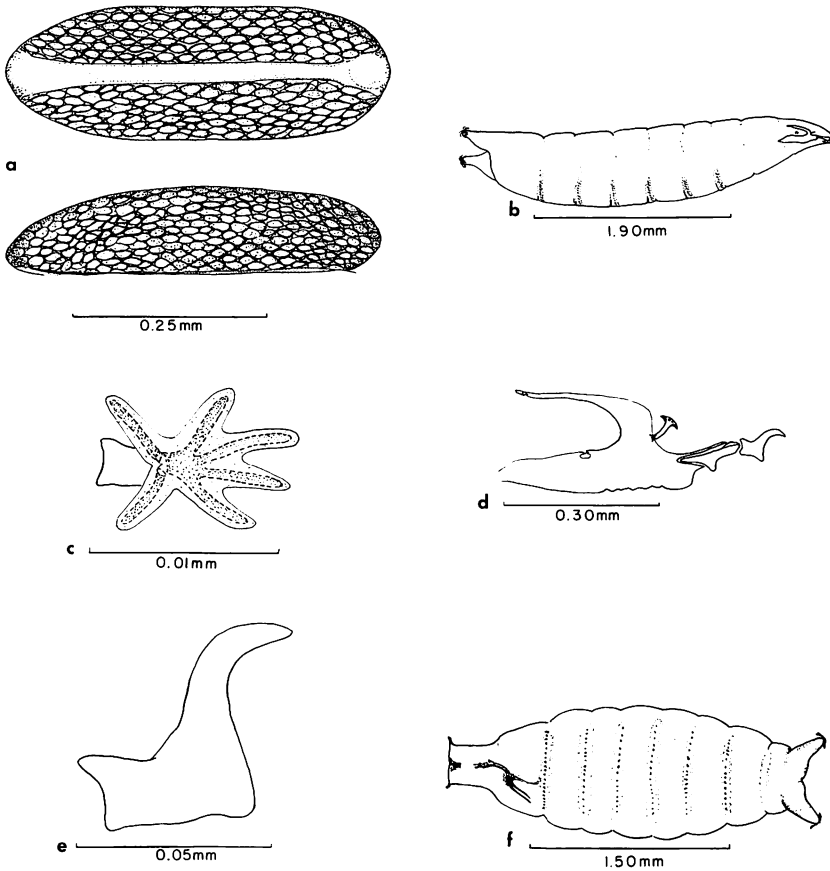


Figure 61—*Leptocera brachystoma* (Stenhammar): a, eggs, dorsal and lateral; b, last instar larva, lateral; c, anterior spiracle of larva; d, cephalopharyngeal skeleton; e, mouth hooks; f, pupa, ventral.

***Leptocera (Limosina) brevivenosa* Tenorio (figs. 68b, 70a-h)**

Leptocera (Limosina) brevivenosa Tenorio, 1967, Proc. Haw. Ent. Soc. 19:425.

Type-locality: Mt. Tantalus, Oahu.

Endemic. First described from Hawaii, Maui, and Oahu (Tantalus). Twenty-one additional specimens have been collected from Kauai (Kahili, 3000 ft., 17 November 1968, J. A. Tenorio); this constitutes a new island record.

This species can be separated from all others known from Hawaii by the characteristic vein $R_2 + 3$, which is short, less than half the length of $R_4 + 5$, and noticeably bent toward the costa (fig. 70a); and by the strong pair of presutural dorsocentrals. The male clasper is illustrated in figure 68b.

Collected from leaf litter in forests and animal dung (probably dog).

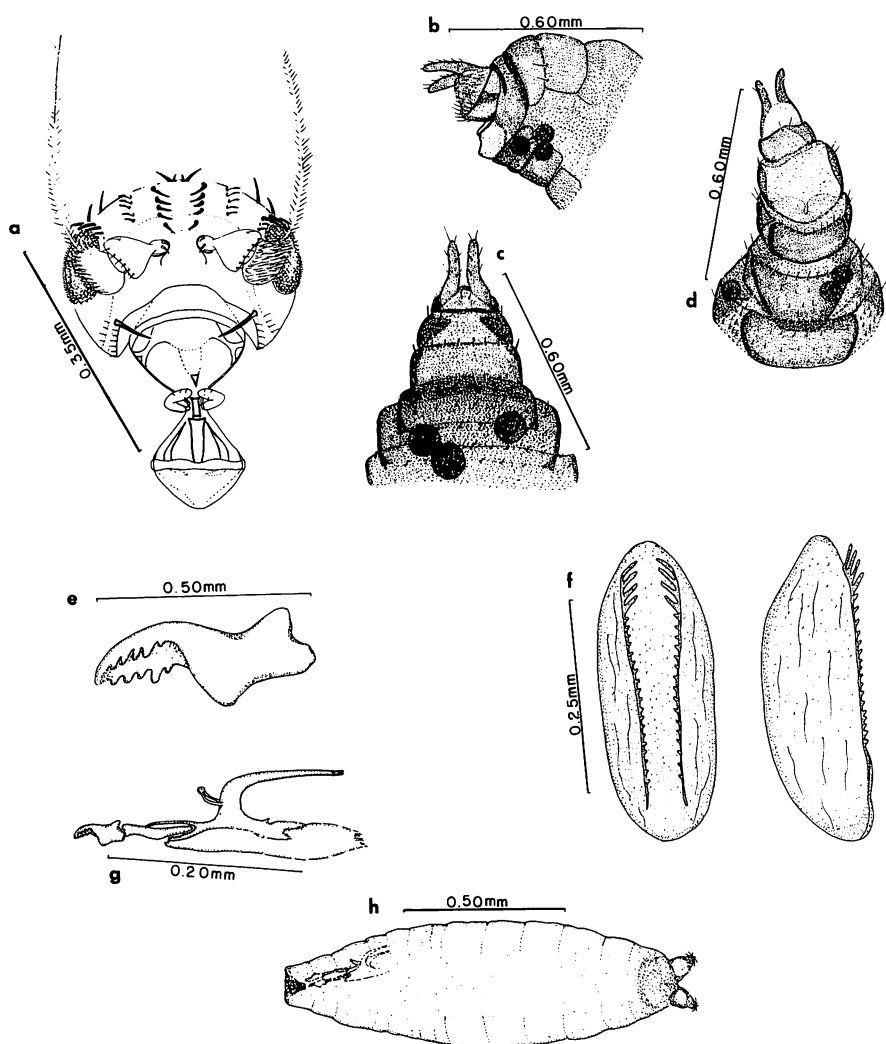


Figure 62—*Leptocera atomus* (Rondani): a, head, anterior; b, female genitalia, lateral; c, female genitalia, dorsal; d, female genitalia, ventral; e, mouth hook; f, eggs, dorsal and lateral; g, cephalopharyngeal skeleton; h, pupa, ventral.

***Leptocera (Limosina) empirica* (Hutton) (fig. 68e)**

Limosina empirica Hutton, 1901, Trans. Proc. N.Z. Inst. 33:94. Type-locality: New Zealand.

References for synonymies of *pectinifera* Villeneuve (1917) and *cadaverina* Duda (1918) Richards, 1930:300; Duda, 1938:137; Harrison, 1959:270.

First reported by Tenorio (1968), this species has been recorded in Hawaii only from Haleakala, Maui.

Immigrant. Europe, England, Iceland, Canada, New Zealand, Campbell Island, Falkland Island, Juan Fernandez. First described from New Zealand.

Of the Hawaiian Sphaeroceridae, this predominantly black species resembles most closely *L. aequalis* (Grimshaw). It differs in the chaetotaxy of the legs of both male and female. Middle tibia has an apical ventral bristle; the middle basitarsus lacks the long ventral bristle near the base, and the hind tibia has a preapical dorsal bristle. The middle leg of the male has a group or tuft of ventral bristles at the basal portion of femur and apical portion of tibia. Male clasper as in figure 68e.

Leptocera (Limosina) heteroneura (Haliday) (fig. 68c)

Limosina heteroneura Haliday, 1836, Ent. Mag. Lond. 3:331. Type-locality: United Kingdom.

Found on Hawaii, Molokai, and Oahu. First recorded from these islands by Tenorio (1968).

Immigrant. Holarctic Region, Formosa. Originally described from the United Kingdom.

Richards (1930) mentioned the following breeding records for this species: damaged narcissus bulbs, decayed green ginger; also found in mole's nest, cormorant's nest, and in caves.

L. heteroneura is similar to *L. brachystoma* and *L. bifrons*. It may be separated from them by the r-m and m crossveins which are situated very close together, the distance between these veins less than half the length of the m crossvein.

Generally brown to black species, legs yellowish. Head with frons shining brown to black. Thorax with two dorsocentral bristles, both behind the suture, the anterior one less than half the length of the posterior one, which is about half as long as the anterior pair of marginal scutellar bristles. Wings hyaline. $R_2 + 3$ strongly bent forward at apex. $R_4 + 5$ bent forward at level of r-m crossvein and meeting the costa before the wing apex. Costa overpassing $R_4 + 5$ by a distance about equal to, or less than, the length of m crossvein. Crossveins r-m and m are separated by a distance half or less than half the length of m. Middle basitarsus more than half as long as middle tibia. Body length approximately equal to wing length, 1.2 mm. Male claspers as in figure 68c.

Leptocera (Limosina) mirabilis (Collin) (figs. 59a-j, 68d)

Limosina mirabilis Collin, 1902, Ent. mon. Mag. 38:59. Type-locality: England.

First recorded by Tenorio (1968) from the islands of Hawaii, Maui, Molokai, Oahu, and Kauai.

Immigrant. Europe and North America. Originally described from England.

Black, usually shining, species. Thorax with only one pair of dorsocentral bristles. The apical margin of the scutellum more or less parallel to the scutellar suture. Sternopleura with one bristle. Hind tibia ventrally with a long

curved bristle arising slightly beyond the middle and extending beyond the apex of the tibia (fig. 59f). Wings hyaline. Second costal sector as long as, or shorter than, the third sector; $R_2 + 3$ bent forward at apex; $R_4 + 5$ slightly curved forward, costa overpassing $R_4 + 5$ only slightly. Male claspers as in figure 68d.

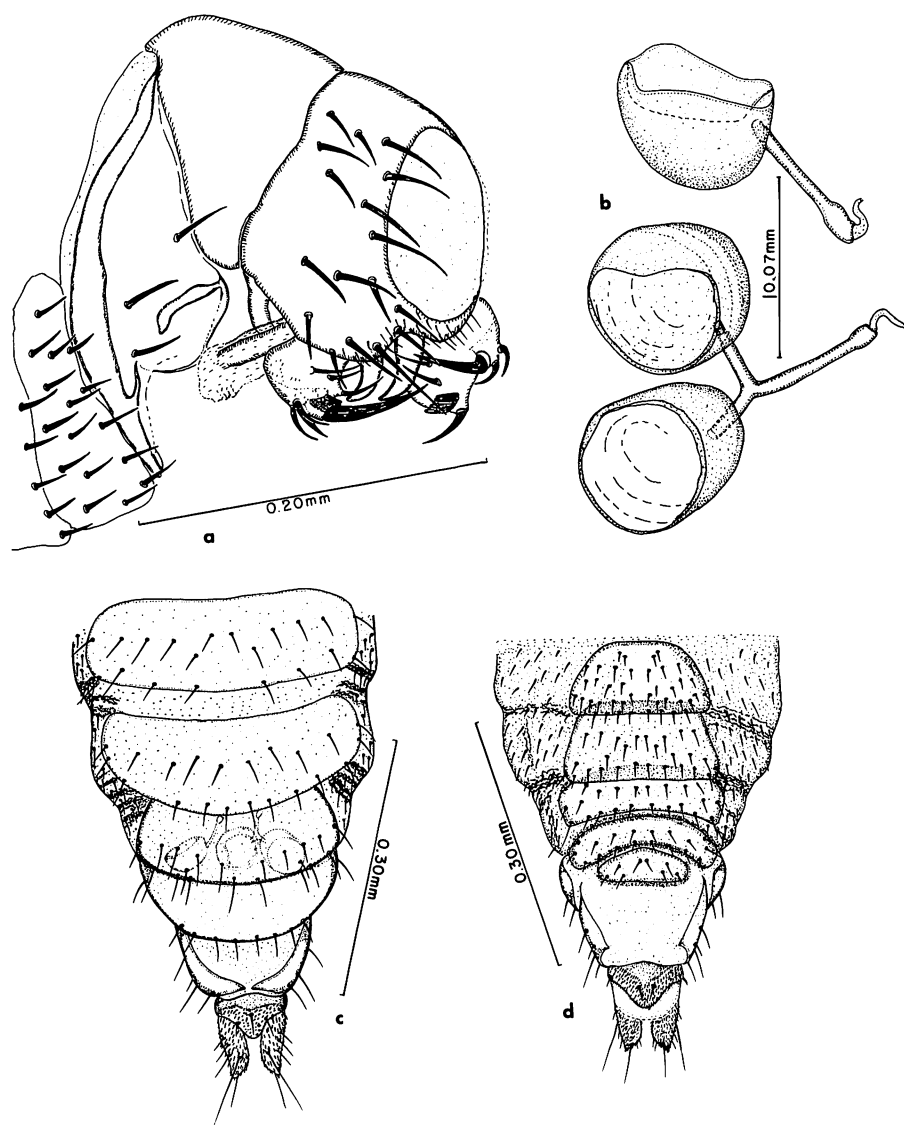


Figure 63—*Leptocera hardyi* Tenorio: a, male genitalia, lateral; b, spermathecae; c, female abdomen, dorsal; d, female abdomen, ventral.

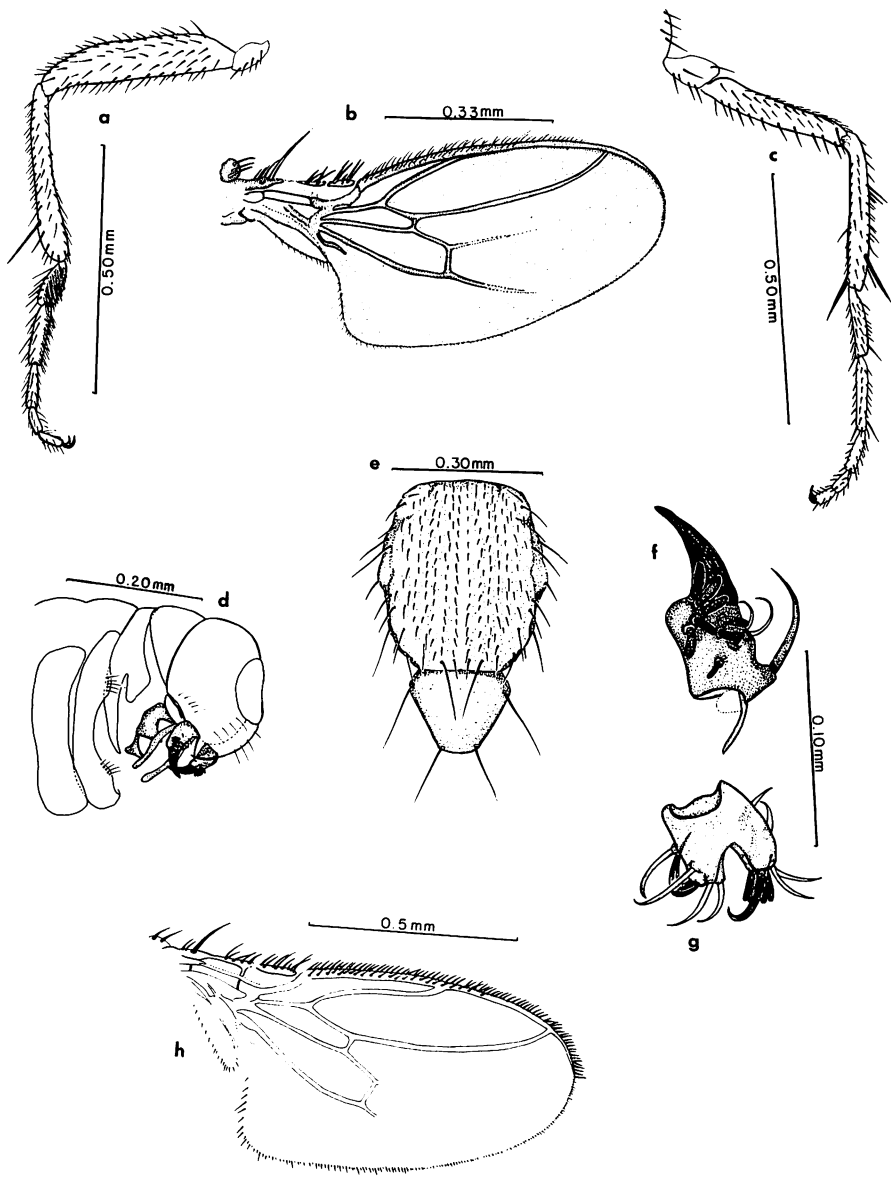


Figure 64—*Leptocera hardyi* Tenorio: a, hind leg of male; b, wing; c, middle leg of male; e, thorax, dorsal; g, surstylus of male. *L. obliqua* Richards; d, male genitalia; f, surstylus of male; h, wing.

This species has been bred both from cow and horse manure. Like *L. atomus* it is frequently seen coming out from beneath manure piles. In the laboratory, it is easily reared in petri dishes containing small amounts of moist horse or cow manure.

Duration of the life cycle varies according to the consistency of the medium. If the manure is constantly kept moist, the life cycle may be completed in as few as 8 days; if the manure is dry, as many as 14 or more days may be required. The egg hatches in about 8 to 24 hours; the larva (fig. 59a) takes from 4 to 8 days; and the pupa (fig. 59e) requires approximately 3 to 6 days. In one of the rearings, the life cycle was completed in 8 days.

The eggs (fig. 59g) of *L. mirabilis* bear finger-like projections around the anterior end. In the substrate, these processes are exposed and lie parallel to the surface. While the larvae and pupae of this species are similar in shape and relative length of the posterior spiracles to those of *L. brachystoma*, they differ in the serration of the larval mouth hooks and the weaker spines or hooks on the body.

Sizes of the immature stages: egg, 0.41 mm. long, 0.11 mm. wide; larva (prepupa), 3.5 mm. long, 0.65 mm. wide; pupa, 2.9 mm. long, 0.75 mm. wide.

Leptocera (Limosina) rufifrons Duda (figs. 60a-f, 68a)

Leptocera (Scotophilella) brevicostata var. *rufifrons* Duda, 1925, Arch. Naturgesch. (A) 90(11):164, 188. Type-locality: Formosa.

References: Richards, 1952:429; 1956:135; 1963:127.

Collected only on Oahu. First recorded by Richards (1952).

Immigrant. Formosa, New Guinea, Abyssinia, E. India, Congo, Micronesia. Originally described from Formosa, New Guinea, and Abyssinia.

The male of this species can be distinguished from the male of *L. brevicostata* by post-abdominal characters, especially the claspers (fig. 68a). The fifth abdominal sternum is set with two separate rows of very closely placed minute bristles near the posterior margin (fig. 60c). The posterior borders of the third and fourth sterna are longer than the anterior borders, the fourth longer than the third.

The females of *rufifrons* are exceedingly difficult to differentiate from those of *brevicostata* Duda.

Specimens were easily reared from cow dung in the laboratory. The following data were recorded from these rearings.

The complete life cycle from egg to adult requires about 12 days; the eggs took from 12 to 48 hours for hatching; the larval stage lasted 4 days; and the pupa took about 7 days, an unusually long period of time for the pupal stage, as compared to other species that were reared. This can probably be accounted for by the fact that the early stage pupae were separated from the substrate to be measured and subsequently placed on moist tissue paper in a petri dish.

The egg (fig. 60e) is reticulated, the reticulations so distinct as to appear

punctate. The lateral processes are thin, rather hair-like and arranged like a comb.

The posterior spiracles of the pupa (fig. 60f) are projecting and are about three-fifths as wide as long. The pupal skin is about two and two-thirds longer than wide.

Sizes of the immature stages: egg, 0.55 mm. long, 0.20 mm. wide; pupa, 1.90 mm. long, 0.69 mm. wide.

This species has also been collected on rotten pepper.

Subgenus **OPACIFRONS** Duda

Limosina, subg. *Opacifrons* Duda, 1918, Abh. zool.-bot. Ges. Wien. 10(1):28.

Type-species, *Limosina coxata* Stenhammar, by subsequent designation by Spuler, 1924b:121.

This subgenus is characterized by the presence of four marginal bristles on the scutellum and a preapical, but no apical, ventral bristle on the middle tibia. Only one species under this subgenus occurs in Hawaii.

Leptocera (Opacifrons) aequalis (Grimshaw) (fig. 67a)

Limosina aequalis Grimshaw, 1901, Fauna Hawaiiensis 3:76. Type-locality: Oahu.

References: Richards, 1952:430; 1956:135.

Endemic. Originally described from Oahu (Kawailoa Gulch). Richards (1952) recorded *aequalis* from the island of Hawaii and it has since been collected from Maui, Molokai, Lanai, and Kauai, thus making complete distribution for the major Hawaiian Islands.

L. aequalis has been collected around water pools and on ginger leaves (probably resting). The authors have observed this species skating on quiet pools of water in association with Ephydridae, especially in forest areas.

Predominantly dark brown to black, this species may be recognized as follows: two pairs of strong dorsocentral bristles present, anterior pair just slightly posterior to the suture; middle femur in male with a weaker anteroventral and a stronger posteroventral comb-like row of about twelve short, stout bristles; middle tibia in male ventrally with very short, comb-like bristles increasing in size apically; and lateral margins of terga three and four in male with long, dense, hair-like bristles. Male clasper as in figure 67a.

Subgenus **PACHYTARSELLA** Richards

Leptocera, subg. *Pachytarsella* Richards, 1963, Insects Micronesia 14(5):124.

Type-species, *Leptocera (Limosina) pachypus* Richards, by original designation.

This subgenus can be distinguished from all others in Hawaii by having only one pair of interfrontal bristles on the frons.

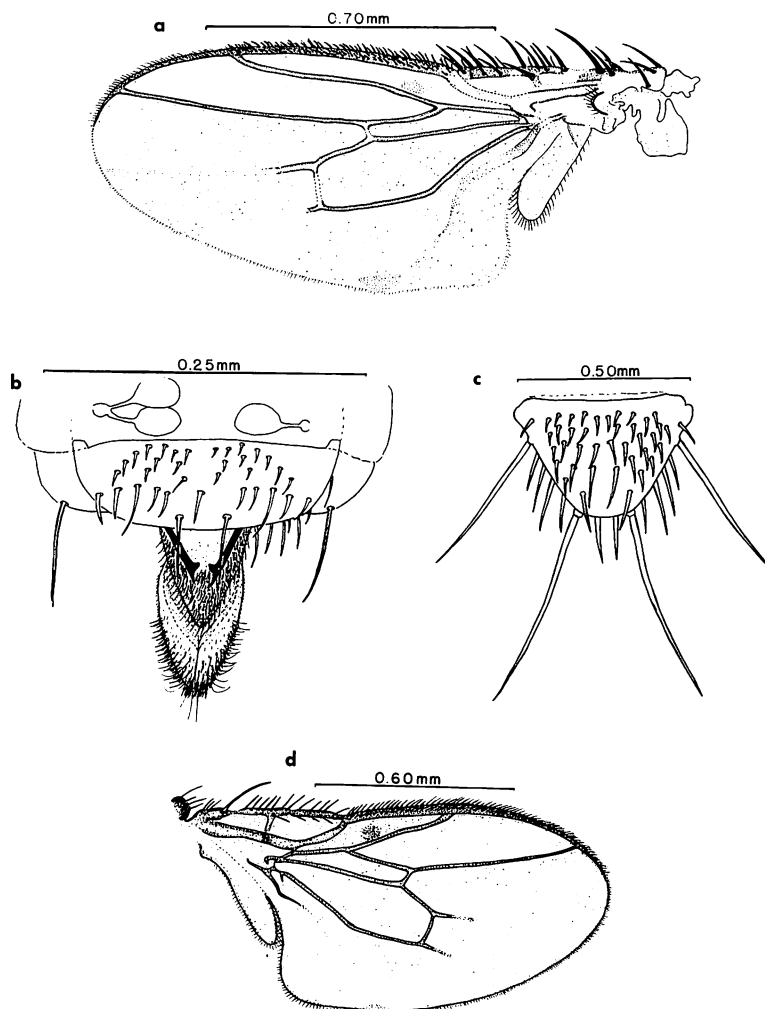


Figure 65—*Leptocera ferruginata* (Stenhammar): a, wing; b, female genitalia, ventral; c, scutellum. *L. hirtula* (Rondani): d, wing.

***Leptocera (Pachytarsella) pachypus* Richards**

Leptocera (Limosina) pachypus Richards, 1956, Proc. Haw. Ent. Soc. 16:135.

Type-locality: Manoa Valley, Oahu.

Reference: Richards, 1963:124.

Originally described from Manoa Valley, Oahu. This species was previously known only from the island of Oahu and only one specimen, in addition to the type series, has been collected on the same island (Tenorio, 1968, leaf litter). Richards (1964:615) reported it also from New Guinea. The data from collection labels suggest that *L. pachypus* occupies relatively humid en-

vironments, probably in forest areas with a moist layer of humus on the ground.

Immigrant? New Guinea.

Richards (1956) suggested the relationship of *L. pachypus* to species in the subgenera *Poecilosomella* Duda and *Mallochella* Duda, but pointed out various characters which made this species distinct from them. At the same time, Richards placed this species "as a rather aberrant member" under the subgenus *Limosina* Macquart. In 1963, he erected a new subgenus *Pachytarsella* and designated *Leptocera (Limosina) pachypus* Richards as the type.

This is the only species from Hawaii in the subgenus *Pachytarsella*. It can be distinguished from other known Hawaii species by the characteristic single pair of interfrontal bristles and by the rounded apex of the discal cell (at the posterior angle).

Subgenus **POECILOSOMELLA** Duda

Leptocera, subg. *Poecilosomella* Duda, 1925, Arch. Naturgesch. (A) 90(1):78.

Type-species, *Boborus punctipennis* Wiedemann, by subsequent designation of Richards, 1930:268.

The striking white spots, especially at the bases of the major bristles of the head and thorax, characterize this subgenus. Only one species under this combination occurs in Hawaii.

Leptocera (Poecilosomella) punctipennis (Wiedemann) (fig. 67c)

Boborus punctipennis Wiedemann, 1824, Analecta ent.:59; 1830, Aussereurop. Zweifl. Ins. 2:599. Type-locality: East India.

References: Richards, 1952:430; 1956:135; 1963:123.

This species appears widespread on most of the six major islands. One female was collected on Laysan Island, 8 April, 1923 (D. T. Fullaway).

Immigrant. Belgian Congo, India, Indo-China, Formosa, Samoa, Micronesia, Southwest Pacific (Santa Cruz Is. and Matoma Is.).

Tenorio (1968) observed this species to be abundant in cow manure. It has been collected by others in poultry, pig and cow manure, and in light traps.

L. punctipennis may be confused with *L. angulata* Thomson, a widely distributed species not known to occur in Hawaii. In *angulata*, vein $R_2 + 3$ runs almost parallel with the costa, then abruptly turns at about a 90° angle toward the costa; in *punctipennis*, $R_2 + 3$ runs gradually closer to the costa apically and turns less abruptly up to the costa, cell $R_2 + 3$ becoming appreciably narrower at apex. We have compared our Hawaiian species with Duda's photograph of *punctipennis* (1925, fig. 12) and these agree well.

Recently, Richards (1965) listed Hawaii under the distribution of *L. angulata*. Since *angulata* has never been recorded from Hawaii to our knowledge, and the Hawaii species is almost certainly *punctipennis*, we feel that Richards has confused the Hawaii *punctipennis* with *angulata* and recorded the

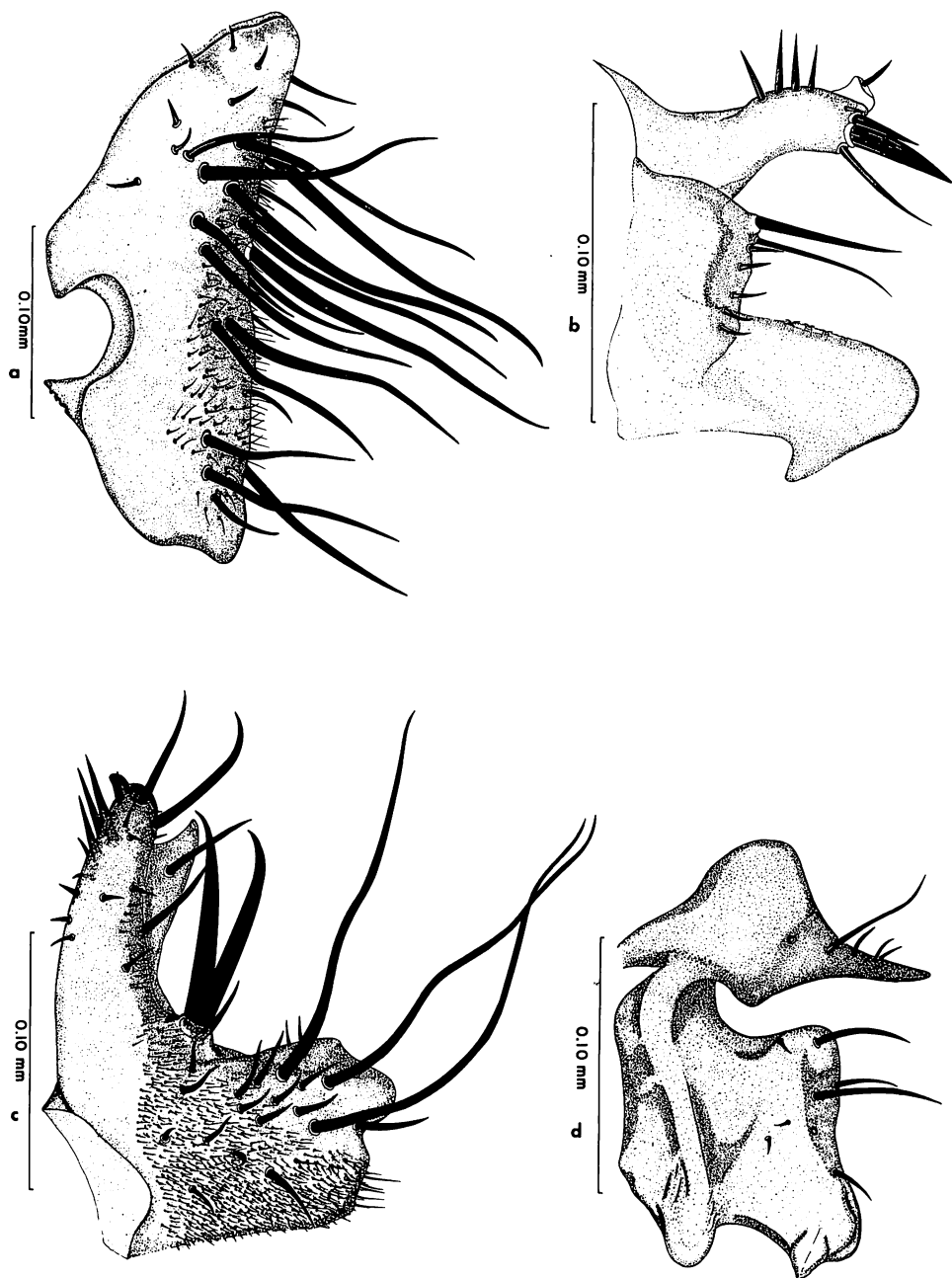


Figure 66—Right surstyli of males: a, *Copromyza equina* Fallén; b, *C. sordida* Zetterstedt; c, *Leptocera abdoniseta* Duda; d, *L. downesi* Richards.

distribution of *punctipennis* as part of the distribution of *angulata*. The male clasper is shown in figure 67c.

Subgenus **RACHISPODA** Lioy

Rachispoda Lioy, 1864, Atti Ist. veneto (3) 9:1116. Type-species, *Copromyza limosa* Fallén, by monotypy.

Limosina, subg. *Collinella* Duda, 1918, Abh. zool. bot. Ges. Wien. 10(1):27 (preocc. Schmidt, 1897). Type-species, *Copromyza limosa* Fallén, by designation of Richards (1930:266).

Leptocera, subg. *Collinellula* Strand, 1928, Arch. Naturgesch. (1926) (A) 92(8):49 (new name for *Collinella* Duda). Type-species, *Copromyza limosa* Duda, automatic.

Subgenus *Rachispoda* has the middle tibia lacking an apical ventral bristle, but with a preapical ventral bristle, the middle trochanter with a long up-curved anteroventral bristle, bristles on the disc of the scutellum, and the anterior pair of dorsocentral bristles not directed inward.

Leptocera (Rachispoda) downesi Richards (fig. 66d)

Leptocera downesi Richards, 1944, Proc. R. Ent. Soc. (Lond.) (B) 13(11-12):137. Type-locality: Scotland (ship from Argentina).

References: Richards, 1952:430; 1956:135; 1963:115; in Stone et al. 1965:721.

Found on the islands of Maui, Oahu, and Kauai, but widespread only on Oahu. Also collected on Laysan and Midway Islands. First reported from Oahu by Richards (1952:430).

Immigrant: Scotland (shipped from Argentina), North America, Micronesia.

Originally described from Glasgow, Scotland, taken from a ship in large numbers "breeding in damp wheat from Argentina" (Richards, 1952). According to Richards, the specimens which he examined from Hawaii "are rather smaller but quite similar and have the same type of male genitalia . . . the curvature of $R_4 + 5$ varies somewhat . . . straighter than usual." However, these differences are minor, and, for this reason, the Hawaiian specimens with these slight variations are considered to be the same as Richards' (1944) species.

Richards (1963:115) reported two females of this species, which were captured on a Philippine clipper on Guam, Mariana Is. No further record of this species has been reported from Micronesia. *L. downesi* has been collected on weeds and at lights.

This species may be recognized by having the scutellar disc with a pair of moderately long bristles and three to five pairs of very short bristles antero-lateral to the long pair; scutellum also with two pairs of long and a pair of moderately long marginal bristles. Male right clasper as in figure 66d.

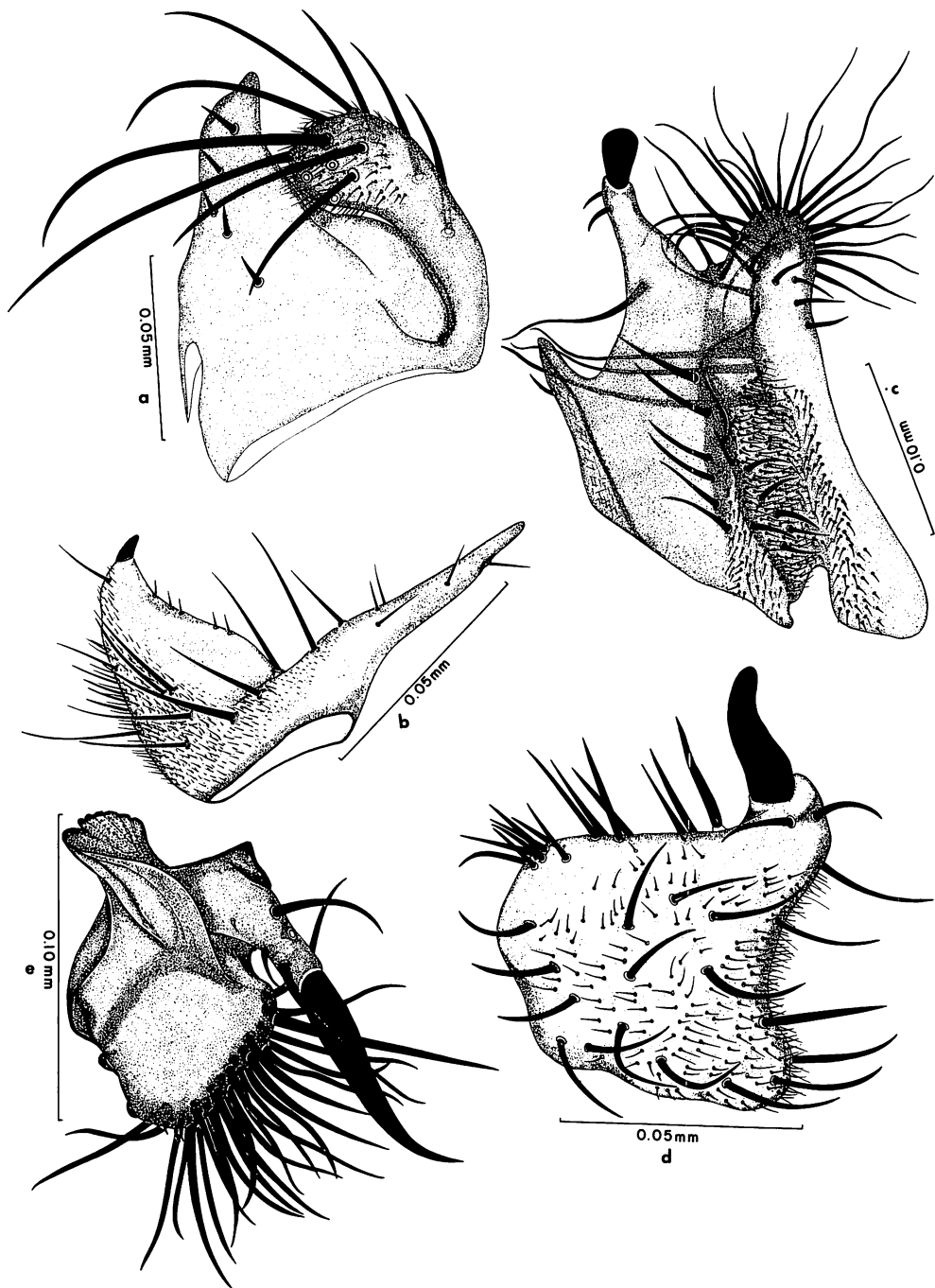


Figure 67—Right surstyli of males: a, *Leptocera aequalis* (Grimshaw); b, *L. brachystoma* (Stenhammar); c, *L. punctipennis* (Wiedemann); d, *L. bifrons* (Stenhammar); e, *L. brevicostata* (Duda).

Subgenus **THORACOAETA** Duda

Limosina, subg. *Thoracoachaeta* Duda, 1918, Abh. zool.-bot. Ges. Wien. 10(1):

32. Type-species, *Borborus zosterae* Haliday, by designation of Spuler (1925b:120).

This subgenus has more than two pairs of dorsocentral bristles, the anterior pair directed inward, and the antennae separated by about the length of one antenna and directed outward. Only one species occurs in Hawaii.

Leptocera (Thoracoachaeta) brachystoma (Stenhammar) (figs. 61a-f, 67b)

Limosina brachystoma Stenhammar, 1854, Kongl. Vet. Akad. Handl. Ser. 3:393. Type-locality: Sweden.

Reference: Richards, 1956:135.

First reported by Tenorio (1968:183) from Maui and Oahu; Lisiansky, Laysan, and Midway Islands. Seven specimens on hand from Hanolii Cove, Hawaii, 30 May 1970 (J. and J. Tenorio). This is a new distribution record for the island of Hawaii.

Immigrant. Europe, North America, Bermuda, Seychelles, Arabia, Mediterranean. Originally described from Sweden.

This relatively small, dull brown to dark brown species can be easily distinguished from other species by the presence of two pairs of incurving presutural dorsocentral bristles close to the anterior margin of the mesonotum. *Head*: Ocelli widely separated; ocellar triangle with two relatively strong and several randomly placed small bristles. Antennae strongly divergent with arista more than four times as long as the pubescent third segment; pubescence on third segment about as long as the pubescence on the arista, but denser. Eyes appear granulated and small in relation to the head. *Thorax*: Four pairs of short dorsocentrals, two pairs in front of suture directed inward. Humeral callus with one bristle directed posteriorly. Middle tibia with a ventral apical bristle, dorsally with a pair of bristles at about basal fourth and a longer pair at apical one third. First costal sector of wing with relatively long bristles, more than twice as long as bristles on second sector; $R_2 + 3$ bent forward at apex; $R_4 + 5$ straight and meeting the costa slightly before the apex of wing. Body and wings about equal in length, 0.90 mm. to 1.20 mm. Male right clasper (fig. 67b).

L. brachystoma was found in seaweed at the high tide line. It seems to occur in relatively small numbers, but breeds prolifically in the laboratory. In the seaweed from which this species was collected, other flies, such as Ephydriidae, Tethinidae, Dolichopodidae, and Empididae were found. In nature, *L. brachystoma* is evidently preyed upon by a species of Empididae, *Cherisodromia hawaiiensis* Melander, as it was observed in the laboratory to catch and feed upon the sphaerocerid. However, *C. hawaiiensis* is apparently a general feeder, as it was also observed to attack and make a meal out of a Tethinidae present in the breeding media.

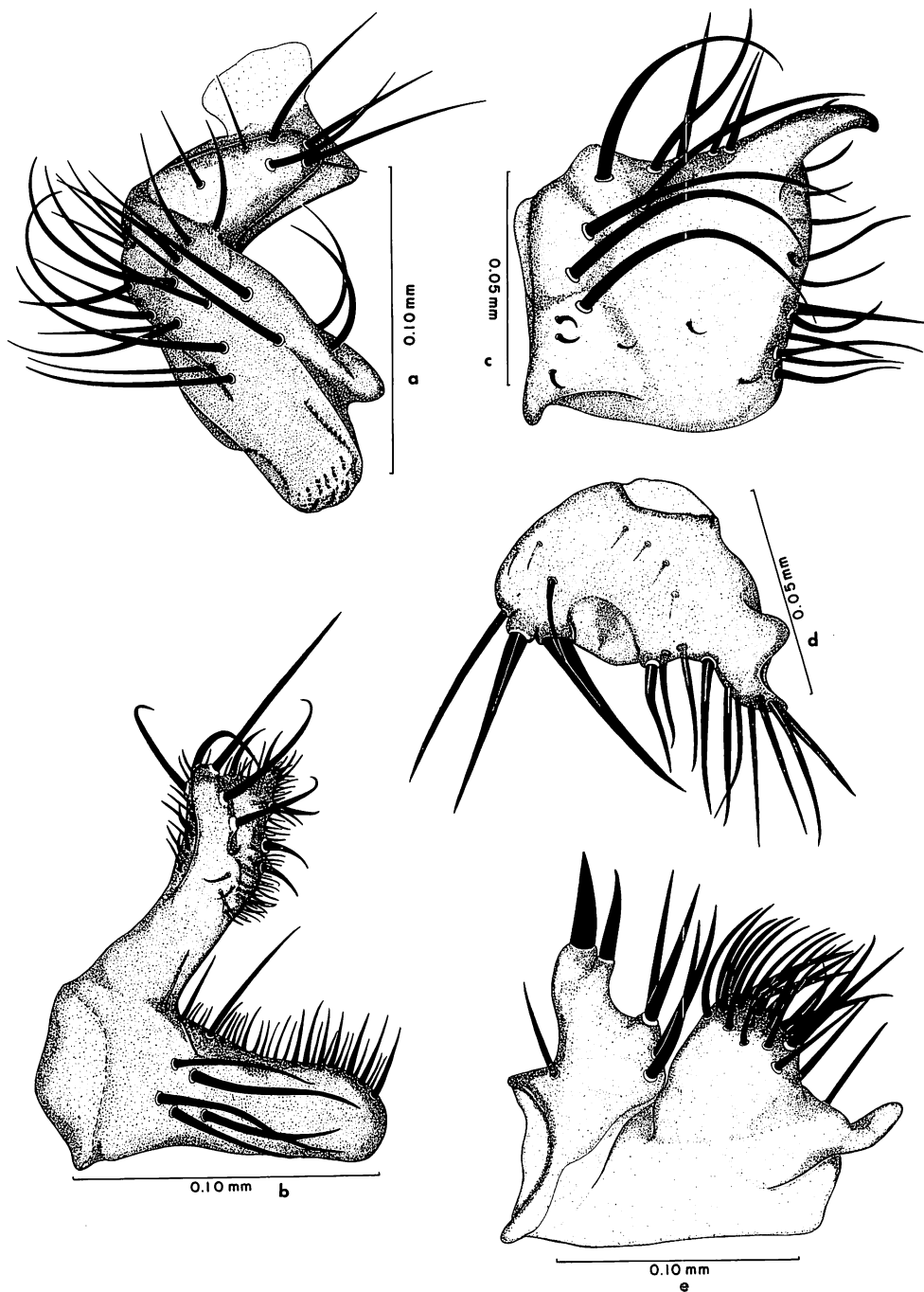


Figure 68—Right surstyli of males: **a**, *Leptocera rufifrons* Duda; **b**, *L. brevivenosa* Tenorio; **c**, *L. heteroneura* (Haliday); **d**, *L. mirabilis* (Collin); **e**, *L. empirica* (Hutton).

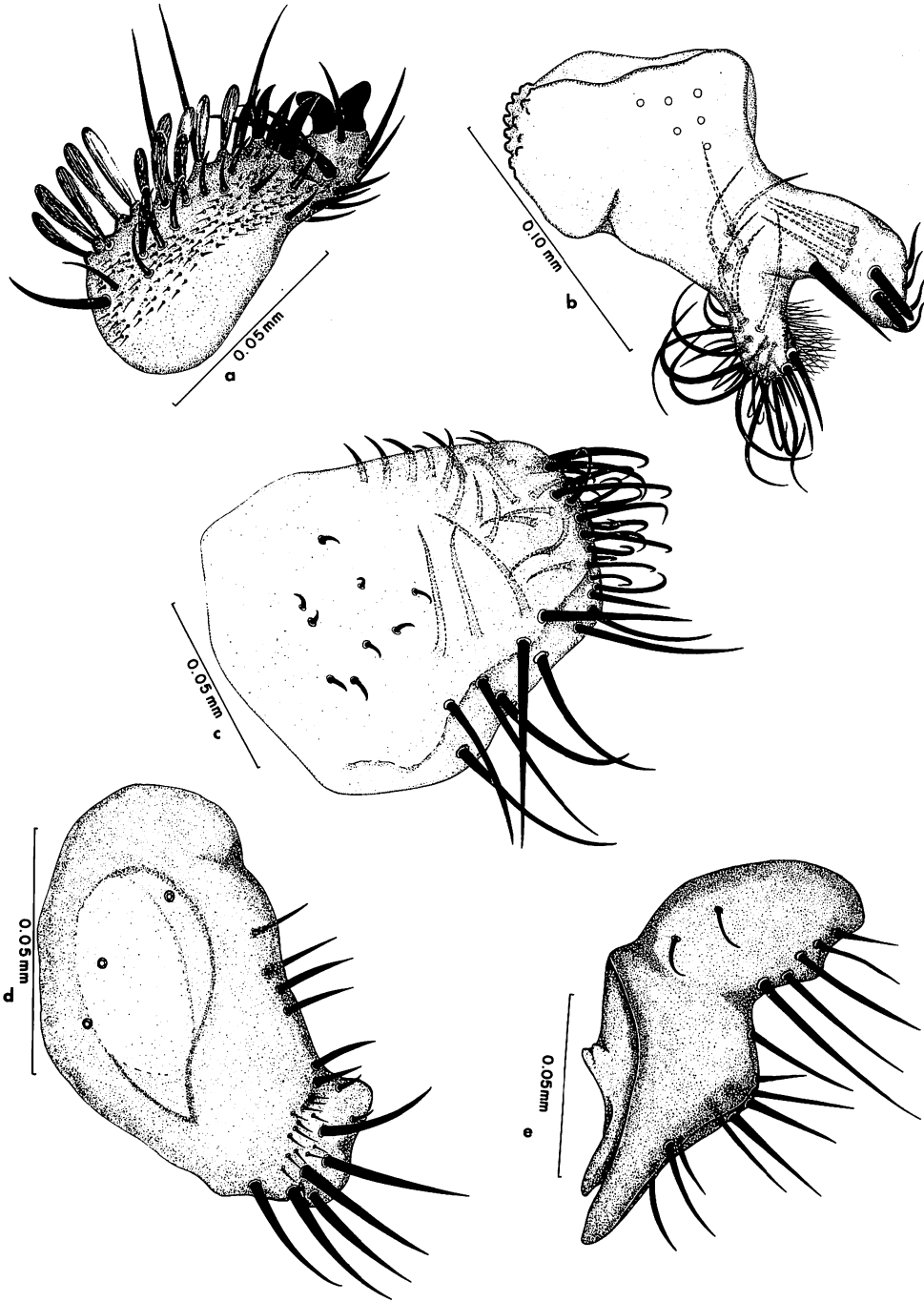


Figure 69—Right surstyli of males: a, *Leptocera atomus* (Rondani); b, *L. acutangula* (Zetterstedt); c, *L. ferruginata* (Stenhammar); d, *L. hirtula* (Rondani); e, *L. vagans* (Haliday).

The complete life cycle, from egg to adult, of this species takes about eleven days. The eggs require from 8 to 24 hours to hatch; the larva develops completely in 5 to 7 days; and the pupa takes approximately 4 days.

The egg chorion, except for the flat (dorsal) surface, is reticulated (fig. 61a); it is otherwise lacking the striking ornamentation of some of the other species. The larva (fig. 61b) and the pupa (fig. 61f), on the other hand, are quite characteristic. The body hooks are distinctly visible; the posterior pair of spiracles is elongated and the anterior pair each with finger-like processes (fig. 61c). Mouth hooks as in figure 61e.

Sizes of the immature stages: egg, 0.48 mm. long, 0.08 mm. wide; larva (prepupa), 2.80 mm. long, 0.70 mm. wide; pupa, 2.40 mm. long, 0.85 mm. wide.

Subgenus **TRACHYOPELLA** Duda

Limosina, subg. *Trachyopella* Duda, 1918, Abh. zool.-bot. Ges. Wien. 10(1):34, 195. Type-species, *Limosina melania* Haliday, by subsequent designation of Spuler, 1925a:103.

Leptocera, subg. *Trachyopella*, Richards, 1930, Proc. Zool. Soc. Lond. 2:266.

This subgenus is characterized by having the frons with a row of bristles about midway between the interfrontal and orbital bristles (fig. 62a). $R_4 + 5$ extremely curved forward, meeting the costa well before the wing apex and the costa extending considerably beyond the apex of $R_4 + 5$.

Leptocera (Trachyopella) atomus (Rondani) (figs. 62a-h, 69a)

Elachisoma atomus Rondani, 1880, Boll. Soc. Ent. ital. 12:19. Type-locality: Italy.

References: Duda, 1918:195; Richards, 1930:306; 1963:129.

First reported from Lanai and Oahu by Tenorio (1968). Two additional specimens have been collected from Maui, Haleakala, Paliku Cabin, 2 September 1968 (G. Kobayashi), constituting a new island record.

Immigrant. Europe, England, Canary Island, Madeira, Belgian Congo, Micronesia. Originally described from Italy.

Very small species. Head bristles are relatively short. Antennae divergent and direct outward; third segment and arista relatively long pubescent. Eyes hairy. Wing with second costal sector and $R_2 + 3$ half, or less than half, as long as the third sector. Costa overpassing $R_4 + 5$ for a considerable distance; this distance about equal to length of $R_2 + 3$. Right clasper of male as in figure 69a.

L. atomus is found commonly in horse manure, generally underneath or in cracks in the manure pile. When the manure is disturbed, this fly can be seen crawling out from underneath the pile, flying a short distance away, and alighting on blades of grasses nearby. It can be readily collected by placing an open plastic bag or net over the manure pile and gently poking the manure. This species has also been collected in chicken manure and taken at light traps.

The complete life cycle of *L. atomus* requires from 10 to 16 days; the eggs hatch in 12 to 24 hours; the larvae take from 5 to 9 days; and the pupae take from 4 to 7 days.

The eggs (fig. 62f) of this species are not reticulated, but have lateral processes which are longest at the anterior end. The mouth hook (fig. 62e) of the larva is distinctly serrated.

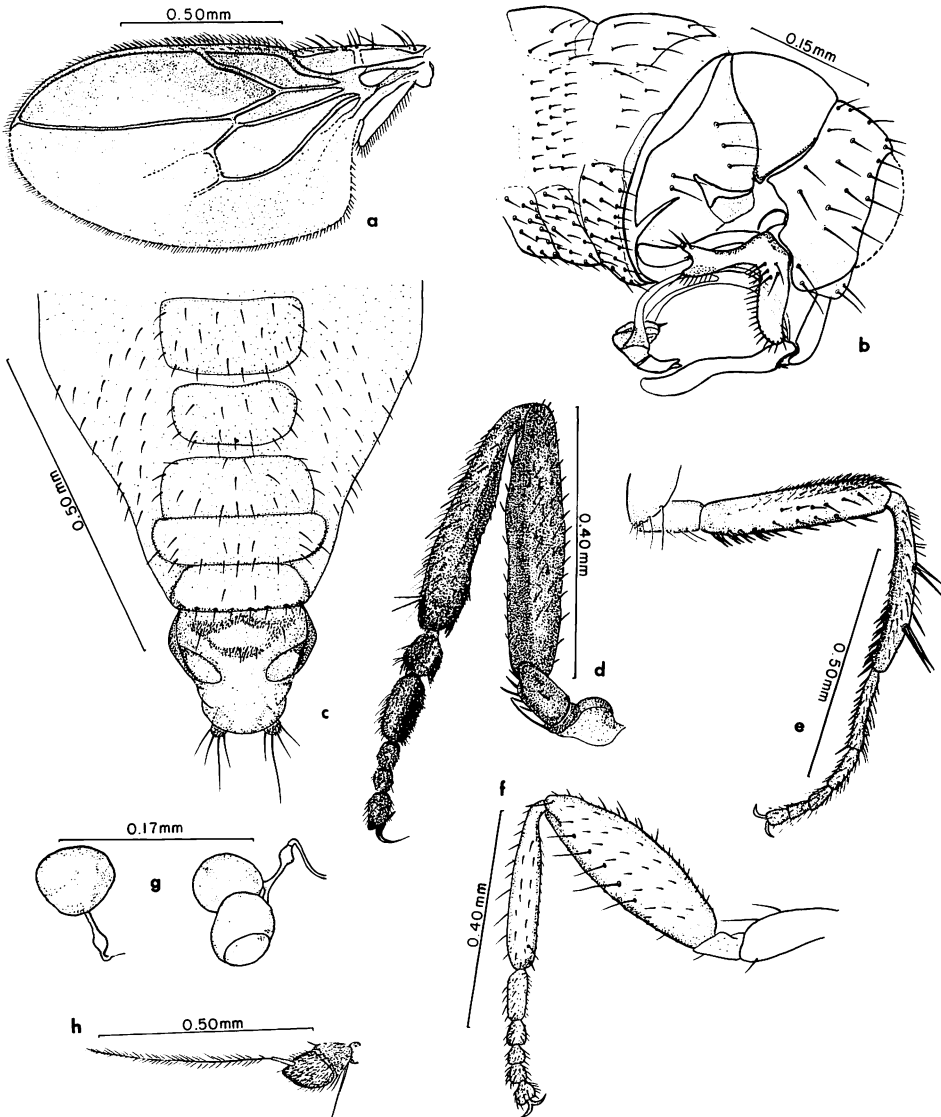


Figure 70—*Leptocera brevivenosa* Tenorio: a, wing; b, male genitalia, lateral; c, female abdomen; d, hind leg of male; e, middle leg of male; f, front leg of male; g, spermathecae; h, antenna.

Sizes of the immature stages: egg, 0.38 mm. long, 0.11 mm. wide; pupa (fig. 62h), 1.65 mm. long, 0.40 mm. wide.

Leptocera (Trachyopella) hardyi Tenorio (figs. 63a-d, 64a-c, e, g)

Leptocera (Trachyopella) hardyi Tenorio, 1967, Proc. Haw. Ent. Soc. 19(3):427. Type-locality: Lanaihale, Lanai.

First described by Tenorio (1967) from Hawaii and Lanai, and further reported by him to be on Oahu (1968).

One specimen from Micronesia has been identified as this species (Tenorio, 1968).

This species has been collected on horse manure and on grass.

L. hardyi is very small, approximately 1.2 mm. in length. It is similar to *Leptocera obliqua* Richards, from which it can be separated by the wing venation in which $R_2 + 3$ is arched and running very close to the costa for a short distance (fig. 64b) and by the male clasper (fig. 64g).

Leptocera (Trachyopella) obliqua Richards (figs. 64d, f, h)

Leptocera (Trachyopella) obliqua Richards, 1963, Insects Micronesia 14(5):129. Type-locality: Ponape.

Tenorio (1968) first reported this species from Oahu. It has not yet been found on the other islands.

Probably an immigrant. Described by Richards from Micronesia.

L. obliqua has been reared from horse manure and taken in light traps.

This species closely resembles *L. hardyi* Tenorio from which it may be separated by having the thorax with three or more irregular rows of acrostichals between the posterior pair of dorsocentral bristles, and vein $R_2 + 3$ removed from, but running almost parallel to, the costa and bending forward at the apex (fig. 64h). Male genitalia as in figures 64d, f.

Family CHYROMYIDAE

Tiny yellow flies which fit near Trixoscelidae by having costa broken only just before end of subcostal vein and the subcostal vein complete, ending in costa, not fused with R_1 ; also cells M and Cu complete. It is differentiated by the all yellow color, by lacking preapical bristles on the tibiae, lacking propleural bristles (according to Wheeler, 1961:89, small propleural bristles are present in *Aphaniosoma*; these are not present on Hawaiian species), spinules on costa, or presutural dorsocentrals, and by the short, inconspicuous palpi.

Hennig (1971:42) has placed the Chyromyidae in the same family group with the Anthomyzidae by having the median portion of the face membranous (semimembranous?) and sunken in; also, by having only two spermathecae.

The antennae are short, the third segment globose and first segment concealed. Palpi short and inconspicuous. Postocellar bristles convergent or ab-

For generic key refer to Wheeler (1961:89).

KEY TO HAWAIIAN GENERA OF CHYROMYIDAE

- Genus
- APHANIOSOMA**
- Becker

Differentiated by the characters given in the generic key. First reported in Hawaii by Hardy (1952e). For a key to Nearctic species refer to Wheeler

(1961:89) and for treatment of the Palearctic species refer to Czerny (1927:52) and Collin (1949).

Two species occur in Hawaii.

***Aphaniosoma macalpinei* Hardy, new species (figs. 71a-d)**

Similar to *minuta* in most details but larger, with the genae very broad, almost equal in width to eye height (fig. 71a); with the hind legs of the male not modified, the basitarsi slender, six times longer than wide not at all flattened dorsocentrally; also, epandrium with a strong apical projection and other details of the genitalia as in figures 71b, c.

MALE. Entirely yellow except for brown tinge on the abdomen. *Head*: Shaped as in figure 71a. The bristles are typical of the genus except that the postocellar bristles are not discernible. The front is densely covered with short erect setae. The arista is broadly yellow on the base, black at apex. Head higher than long with lower margin of eye not so sharply oblique as in *minuta* with the genae much broader in proportion to the eye height. *Thorax*: All yellow, prescutellar acrostichal setae moderately developed, about ten rows of acrostichals over anterior portion of mesonotum and four-six rows in line with the posterior dorsocentrals. *Legs*: Entirely yellow. Hind basitarsi slender, six or more times longer than wide. *Abdomen*: Yellow, tinged reddish-brown on basal two-thirds of each tergum; the apices are yellow-gray. Fifth sternum lacking bristles, and with scattered weak setae. Epandrium with a pair of strong apical projections. Other details of genitalia as in figures 71b, c.

Length: body and wings, 1.8–2.15 mm.

FEMALE. Fitting description of male except for sexual characters. Two flat, round spermathecae present (fig. 71d).

Holotype male and allotype female, Waialua Beach, Molokai, July, 1952 (M. Tamashiro). Paratypes following localities on Oahu: Waimanalo, September, 1951, collected on *Scaevola frutescens* (D. E. Hardy) and September 25–October 2, 1966 (J. R. Vockeroth); Kailua, Oahu, October 12, 1969 (L. Teramoto); and Honolulu, January–December 1952–1966, some in light trap (C. R. Joyce). Molokai: same as type and Kamiloloa, July 20, 1963 (D. E. Hardy).

Type, allotype and some paratypes in B. P. Bishop Museum. Other paratypes deposited in the following collections: U.S. National Museum, Canada Department of Agriculture, British Museum (Natural History), and the University of Hawaii.

It is a pleasure to name the species after Dr. J. F. McAlpine, Canada Department of Agriculture, who studied our Chyromyidae and designated our undescribed species.

***Aphaniosoma minuta* Hardy, new species (figs. 71e-h)**

Fitting in the group of species which have the thorax and legs entirely yellow and numerous rows of acrostichal setae; and differing by having the front

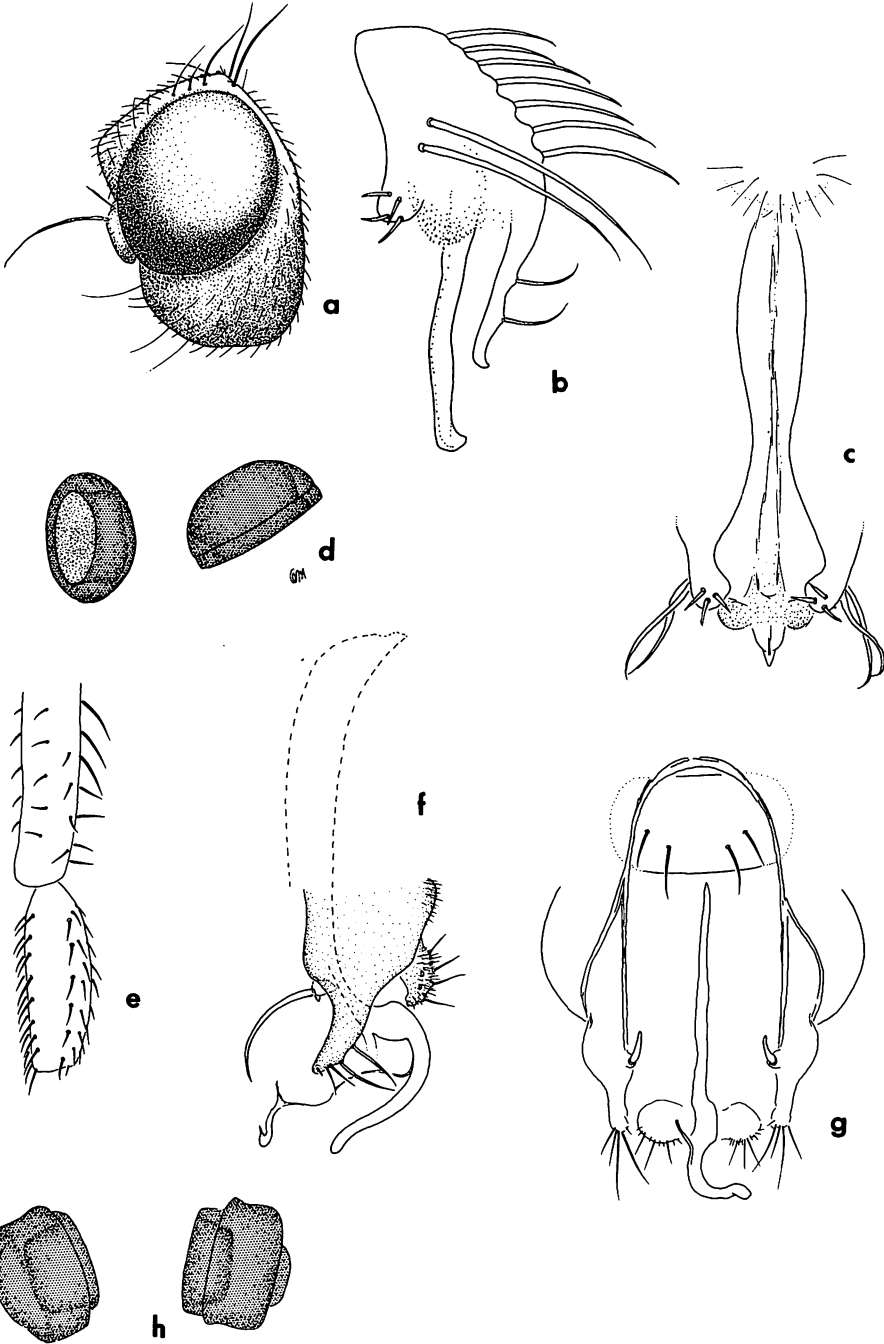


Figure 71—*Aphaniosoma macalpinei* Hardy, n. sp.: a, head, lateral; b, male genitalia, lateral; c, apical portion of genitalia, dorsal; d, spermathecae. *A. minuta*, n. sp.: e, hind basitarsus and tibia; f, male genitalia, lateral; g, genitalia, dorsal; h, spermathecae.

basitarsus of the male flat and broad, and by the very characteristic structures of the male genitalia (figs. 71f, g).

MALE. Yellow species except for tinge of brown on abdomen and on metanotum. *Head:* Higher than long as seen in lateral view with the hind margin of the compound eyes diagonal. The genae comparatively narrow anteriorly and, when measured through the median portion, only about one-third to nearly one-half the eye height. The head bristles are entirely yellow and are arranged as in other members of this genus except that no postocellars are developed. Numerous short erect setae are scattered over the front. Arista brown except for the yellow base. *Thorax:* Entirely yellow except for a tinge of brown on metanotum. One pair of rather strong prescutellar acrostichals, almost equal in length to anterior dorsocentrals. About eight rows of acrostichal setae over anterior half of mesonotum, narrowing to about four rows in line with posterior dorsocentrals. Hind tibiae slightly flattened laterally and with two rows of prominent erect setae extending down anterior surface. Hind basitarsus rather strongly flattened dorsoventrally, broad, equal in width to tibia; scarcely over two times longer than wide, with a slight keel and a row of short erect setae down midline and another row of erect setae down anterodorsal line (fig. 71e). The basitarsus is about equal in length to next three tarsomeres. *Wings:* Apparently the same as in other species of this genus. *Abdomen:* Yellow, tinged with brown and with numerous erect yellow setae especially over posterior portion. Abdomen mostly shining, terga two-four each with a broad gray pollinose band across hind margin. Fifth sternum with four bristles on posterior margin. Epandrium lacking dorsal projections and the details of the genitalia as in figures 71f, g.

Length: body and wings, 1.0–1.2 mm.

FEMALE. Fitting the general characteristics of the male, lacking the modifications on the hind legs. Spermathecae hat-shaped as in figure 71h.

Length: body and wings, 1.5–2.0 mm.

Holotype male and allotype female, Waipahu, Oahu, September, 1955 (D. E. Hardy). 48 paratypes, 34 males, 8 females, same data as type; one female Lahaina, Maui, May 14, 1960 (F. Haramoto); one female Ewa, Oahu, April 25, 1964 (J. W. Beardsley); two females Honolulu, Oahu, December, 1952 and April, 1951 (D. E. Hardy).

Type, allotype and some paratypes in B. P. Bishop Museum, remainder of paratypes in collections of U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

Dr. J. F. McAlpine, Canada Department of Agriculture confirmed that this is a new species and one female specimen is on hand which he has placed here, from Key Largo, Florida, March 31, 1962 (J. E. Vockeroth). We are not designating this in the type series.

Genus **GYMNOCHIROMYIA** Hendel

Gymnochiromyia Hendel, 1933, Dt. Ent. Z. 1933:43. Type-species, *Peletophila minima* Becker, by original designation.

Differentiated by the characters given in the generic key. This has been previously reported in our literature as *Chyromya* Desvoidy (Hardy, 1952a: 465).

Only one species is known from Hawaii.

***Gymnochiromyia hawaiiensis* Hardy, new species (figs. 72a-d)**

This has previously been recorded in the Hawaiian literature as *Chiromyia* (*Scyphella*) *flava* (Linnaeus) by Giffard (1919) and Bryan (1926a) also as *Chyromya* sp.?, by Hardy (1952a:465). A wide assortment of species of this family have been misidentified in the world literature as *flava*; the Hawaiian species is not even congeneric with this.

In Malloch's key (1914:180) this runs to *concolor* Malloch, from North America. According to Malloch's brief description *concolor* is differentiated by having the r-m crossvein ("inner") at or near middle of cell 1st M_2 (discal cell) and by having moderately strong dorsocentral bristles, with a third pair generally distinct. In *hawaiiensis* the r-m crossvein is situated near apical two-thirds of cell 1st M_2 and only one pair of strong dorsocentrals is present. A secondary dorsocentral is represented by a small bristle scarcely two times larger than other thoracic setae, situated immediately in front of the strong pair. This series has been studied by Dr. J. F. McAlpine, Canada Department of Agriculture, and he has indicated it as a new species. It is very probably readily differentiated from other *Gymnochiromyia* by the male genital characters (figs. 72b, c). The strong bilobed surstyli, readily visible *in situ*, will no doubt characterize this species.

MALE. An entirely yellow species sometimes with faint tinges of brown on

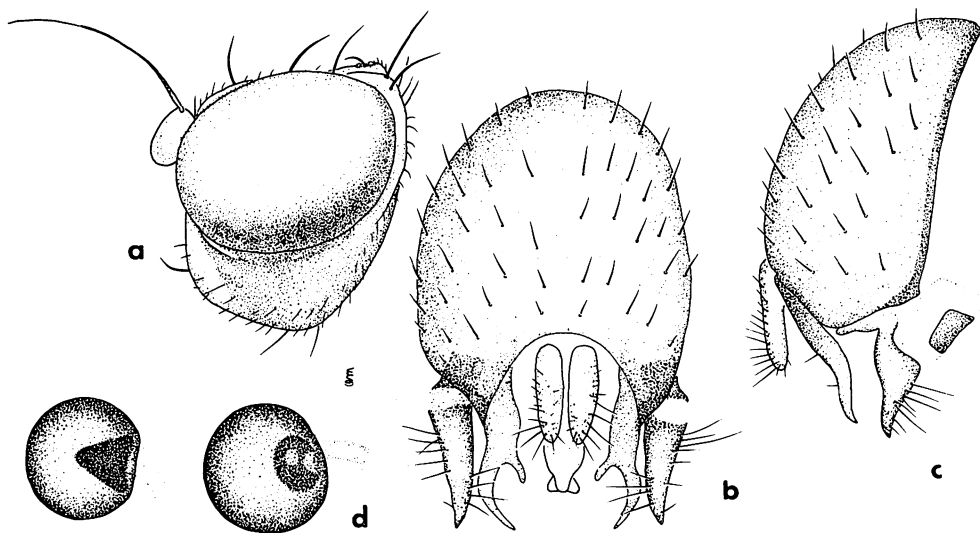


Figure 72—*Gymnochiromyia hawaiiensis* Hardy, n. sp.: a, head, lateral; b, male genitalia, ventral; c, genitalia, lateral; d, spermathecae.

the abdominal terga. *Head*: Slightly higher than long with the eye longer than high, with the lower margin oblique and the genae rather broad (fig. 72a); head bristles as in other members of this genus with the postocellars small, cruciate. *Thorax*: With approximately eight rows of acrostichal setae over anterior half of mesonotum, six rows in the area opposite the posterior notopleural bristles and four rows opposite the posterior dorsocentrals. *Legs*: Hind femora slightly swollen, distinctly larger than other pairs. Hind basitarsi slender, approximately one-half as long as tibiae. *Wings*: As in other members of this genus, except that the r-m crossvein is situated at apical two-thirds of cell 1st M₂. *Abdomen*: Entirely pale yellow in the type and discolored with brown in some specimens. The epandrium is very large, covering the entire apex of the abdomen and very conspicuous *in situ*. The surstyli are divided into two large lobes and the other details of the genitalia are as in figures 72b, c.

Length: body and wings, 1.8–2.0 mm.

FEMALE. Similar to the male in most respects although the eye is more nearly round, approximately as long as high and the genae are narrower in proportion to the eye height, approximately one-third to one-fourth as high as eye. Abdomen with a rather prominent flap-like plate developed on each side just beyond the fifth segment; this probably represents a divided sixth tergum and extends part way onto the venter. Two heavily sclerotized, round spermathecae (fig. 72d).

Holotype male and allotype female, University of Hawaii Campus, Oahu, May, 1952, at light (D. E. Hardy). Over 100 paratypes, approximately two-thirds females mostly collected on windows. Oahu: same as type; Barber's Point, February, 1954 (D. E. Hardy), Honolulu, February–December 1934–1967 (O. H. Swezey, D. E. Hardy, J. W. Beardsley, F. X. Williams, J. R. Vockeroth, C. R. Joyce, and E. Dresner); Waipio, collected on *Atriplex*, April 7, 1960 (D. E. Hardy); Lanipo, April, 1951, on *Acacia koa* (M. Tamashiro); Sunset Beach, Fire Station, no date or collector. Maui: Waihee, June 1952, at light (D. E. Hardy and M. Tamashiro); Kahului, April 20, 1971 on passion fruit foliage (K. Kawamura). Hawaii: Keaau Orchard, light trap, February, 1958 (D. E. Hardy); Makalawena Tract, North Kona, February, 1970 (D. E. Hardy); Puu Anahuhu, Hawaii, on morning glory flower, June 27, 1963 (D. E. Hardy).

Type, allotype, and some paratypes in B. P. Bishop Museum. Other paratypes in collections of U.S. National Museum, British Museum (Natural History), Canada Department of Agriculture, and the University of Hawaii.

Family LONCHAEIDAE

Rather small, metallic black, blue or greenish flies characterized by the narrow head, higher than long with occiput concave or flat, scarcely visible beyond eye margin; eyes large, vertically semicircular; front narrow, less than one-fourth as wide as head, rather densely setose and with only one pair (superior fronto-orbital) of orbital bristles (in Hawaiian species); also with

about six erect hairs in ocellar triangle; postocellar bristles close together, their bases separated by about width of one ocellus, and rather small, equal in size to setae in ocellar triangle. Wing with a prominent curved bristle on dorsal surface of costa below humerus (in Hawaiian species); third antennal segment rather cylindrical, about two or three times longer than wide (figs. 73a, 74b); tibiae lacking preapical dorsal bristles; subcosta complete, costa broken only at end of subcosta and cell M (2nd basal) and cubital cell short (fig. 74c). The females have three large spermathecae plus what appears to be one rudimentary. The latter is referred to by McAlpine (1960a) as "gland at juncture of spermathecal ducts."

The only modern monographs are by Morge (1959, 1963), dealing with Palaearctic species. For generic key refer to McAlpine (1960a:329) and for generic descriptions to McAlpine (1964).

The larvae of various genera and species of the family occupy a wide assortment of habitats; most are scavengers; many are predators; some are fungivores; and some are gall formers in grasses. Shewell, in Stone, et al., 1965:715 says "the immature stages of most species are secondary invaders in diseased or injured plant materials."

Only three (introduced) species are known from Hawaii; these have all been reared from rotting vegetation and are apparently scavengers.

KEY TO HAWAIIAN SPECIES OF LONCHAEIDAE

1. Lunule setose. Third antennal segment three times longer than wide (fig. 75b). Metallic blue to black species. **Lonchaea** Fallén. 2
 Lunule bare. Third antenna short, slightly less than two times longer than wide (fig. 73a). Metallic green species.
 **Lamprolonchaea metatarsata** Kertész.
2. Thorax and abdomen polished black. Front dull, microscopically gray pubescent. Hind basitarsi lacking spines. Male genitalia as in figure 74d.
 **polita** Say.
 Thorax and abdomen metallic blue. Front shining black. Hind basitarsi each with a pair of posterior spines near base in male. Male genitalia as in figure 75d. **striatifrons** Malloch.

Genus **LAMPROLONCHAEA** Bezzi

Lonchaea, subg. *Lamprolonchaea* Bezzi, 1920, Bull. ent. Res. 11:199. Type-species, *Lonchaea aurifrons* Macquart, by original designation.

References: McAlpine, 1960a:329; 1964:693; 1970:442.

Characterized by the bare lunule; short third antennal segment (fig. 73a); facial carina extending longitudinally down face; and by the convergent veins $R_4 + 5$ and $M_1 + 2$ (fig. 73b). Arista short pubescent. Mesopleuron with two strong posterior and several anterodorsal bristles, and sternopleuron with one strong bristle in addition to a few fine hairs.

One species known in Hawaii.

Lamprolonchaea metatarsata (Kertész) (figs. 73a-e)

Lonchaea metatarsata Kertész, 1901, Termeszt. Füzet. 24:83. Type-locality: New Guinea.

Oahu, Kauai, Maui, Hawaii. Probably on other Hawaiian Islands. First reported on Oahu, January, 1951, in fruit fly trap containing casein hydrolysate lure (Hardy, 1952a:473, 1952c, d).

Immigrant. Widespread over Indo-Australian Region and Pacific Islands.

The larvae live in rotting vegetation and are evidently scavengers.

In Hawaii it has been reared from rotting potatoes, stems of rotting banana, rotting bark of *Cheirodendron* and *Charpentiera*, and from rotting fruit of guava.

This species has been previously referred to in the Hawaiian literature as *Lamprolonchaea aurea* (Macquart). The name has been corrected by J. F. McAlpine (pers. comm.), who says "this species is treated in detail in a paper now in press on all the Lonchaeidae described by Kertész."

A rather small species easily recognized by its polished greenish color, confluent veins $R_4 + 5$ and $M_1 + 2$; dull black, minutely roughened front; in combination with the bare lunule, short third antennal segment (fig. 73a), and other generic characters. Wing as in figure 73b. Female with three large, brown, oblong, smooth spermathecae plus one elongate densely spiculated rudimentary ("gland at juncture of spermathecal ducts") (fig. 73d). Male genitalia as in figure 73d, with aedeagus well developed, elongate, tube-like, and with a fringe of long curved hairs on margin of each epandrium. Refer also to figures by McAlpine (1970:151, figs. 22-24).

Length: body and wings, 2.5-3.0 mm.

Genus **LONCHAEA** Fallén

Lonchaea Fallén, 1820, Orthalides Svec.:25. Type-species, *Musca chorea* Fabricius, by designation of Westwood, 1840:150.

References: McAlpine, 1960:348; 1964:712.

Lasiolonchaea Enderlein, 1936, Tierwelt Mitteleur. 6(3):152. Type-species, *Lonchaea hirticeps* Zett., by original designation.

Mastigmas Enderlein, 1927, Stettin. ent. Ztg. 88:105 (as an ulidiid). Type-species, *togoensis* Enderlein, by original designation.

Lonchaea, subg. *Tricholonchaea* Czerny, 1934, Die Flieg. Palaearkt. Reg. 5:21. Type-species, *Lonchaea albitarsis* Zett., by original designation.

The Hawaiian species of this genus are readily recognized by the setulose

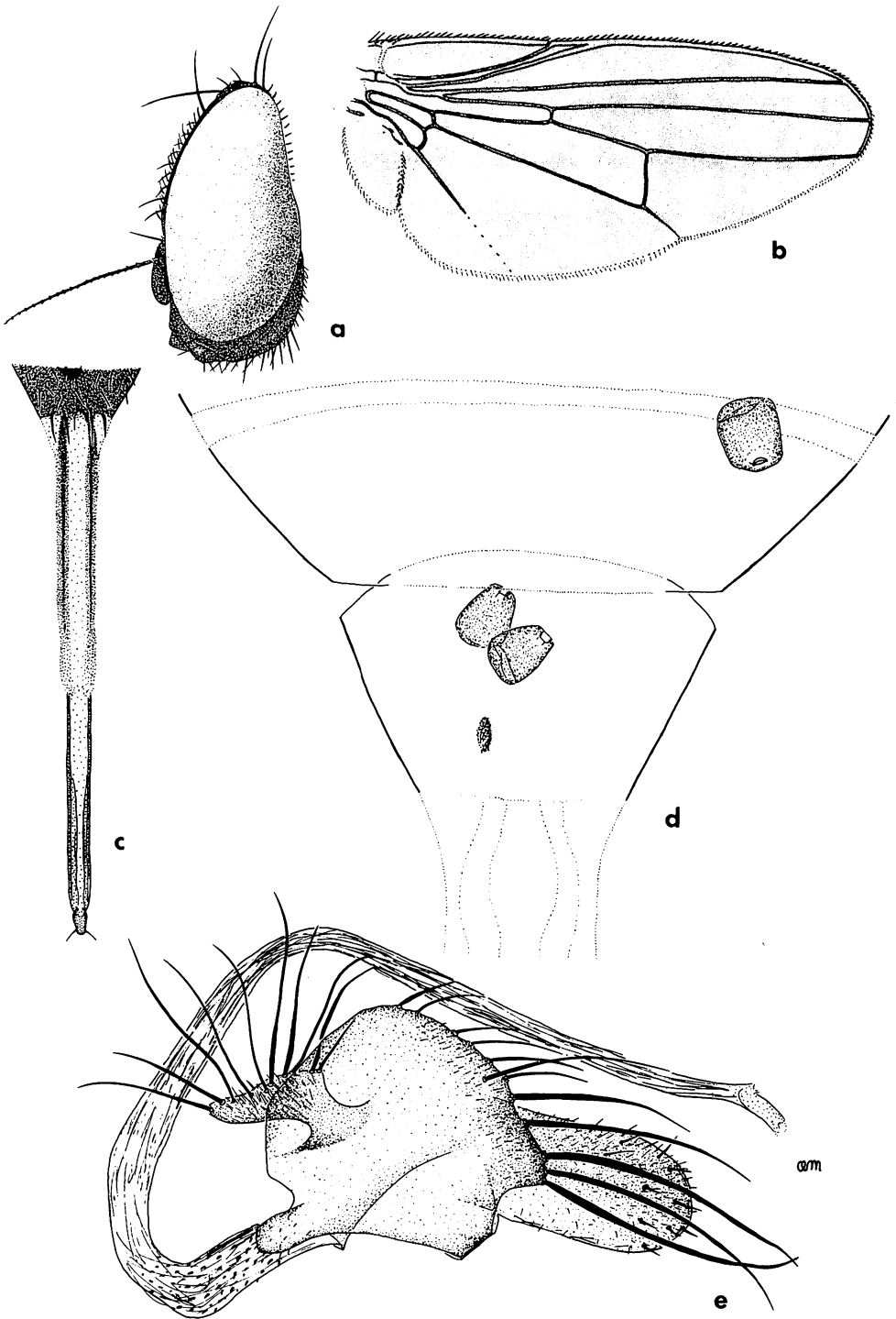


Figure 73—*Lamprolonchaea metatarsata* (Kertész): a, head; b, wing; c, female ovipositor; d, spermathecae; e, male genitalia, lateral.

lunule; elongate third antennal segment (fig. 75b); parallel veins $R_4 + 5$ and $M_1 + 2$ (fig. 74c); and poorly-developed aedeagus in the male (fig. 75d). Surstylus mostly enclosed by epandrium, scarcely, if at all visible from lateral view and lacking strong teeth.

Two species have been reported from Hawaii.

***Lonchaea polita* Say (figs. 74a-d)**

Lonchaea polita Say, 1830, J. Nat. Sci. Philad. (1829-1830) 6:188. Type-locality: Indiana, U.S.A.

Lonchaea rufitarsis Macquart, 1951, Mem. Soc. Sci. Agric. Lille 1850:273. Type-locality: North America.

Reference: Malloch and McAtee (1924:5 [key]).

Oahu, Maui, Hawaii, and probably on all of the main islands. This species has not been previously recorded from Hawaii.

Immigrant. Widespread in U.S., S. Canada. According to McAlpine (pers. comm.), this is one of the commonest and most widely distributed species in North America; it occurs throughout the austral zone. The larvae live on a wide variety of decaying vegetable matter. It has been reared from rotting bark of *Clermontia*, *Cheirodendron*, *Charpentiera*, *Urera*, *Tetraplasandra*, *Hibiscus*, *Pisonia*; also from rotting fruits of *Solanum sodomium* L. These plants were infested with native *Drosophila*, and the *Lonchaea* may be secondary invaders.

This species is characterized by having the thorax and abdomen polished black; the front dull, microscopically gray pubescent; hind basitarsi lacking spines; male cerci rather short, narrow, not extended into elongate lobes; margin of epandrium rather short setose (fig. 74d) compared to *striatifrons* (fig. 75d). The head is as in figure 74b. The front of male is slightly convergent below. The wings as in figure 74c. Male genitalia as in figure 74d and female ovipositor and spermathecae as in figure 74a.

Length: body and wings, 2.75-3.0 mm.

***Lonchaea striatifrons* Malloch (figs. 75a-d)**

Lonchaea striatifrons Malloch, 1920, Can. Ent. 52:246. Type-locality: Santa Clara, California, U.S.A.

Lonchaea occidentalis Malloch, 1923, Proc. Ent. Soc. Wash. 25:46. Type-locality: Arizona, U.S.A.

Maui, Lanai, Molokai, Hawaii, and probably on all the main islands. This is the first record of this species in Hawaii.

Immigrant. Southwestern United States and Mexico, apparently living in arid areas. It has been reared from rotting Sodom apple (*Solanum sodomium*), rotting stems of *Hibiscus arnottianus*, *Dracaena* sp., and *Cheirodendron* sp. in Hawaii; from diseased *Dasyllirion*, a yucca-like plant; and from *Cereus gigantea*, a cactus in Arizona.

Differentiated by the metallic blue thorax and abdomen, presence of a pair

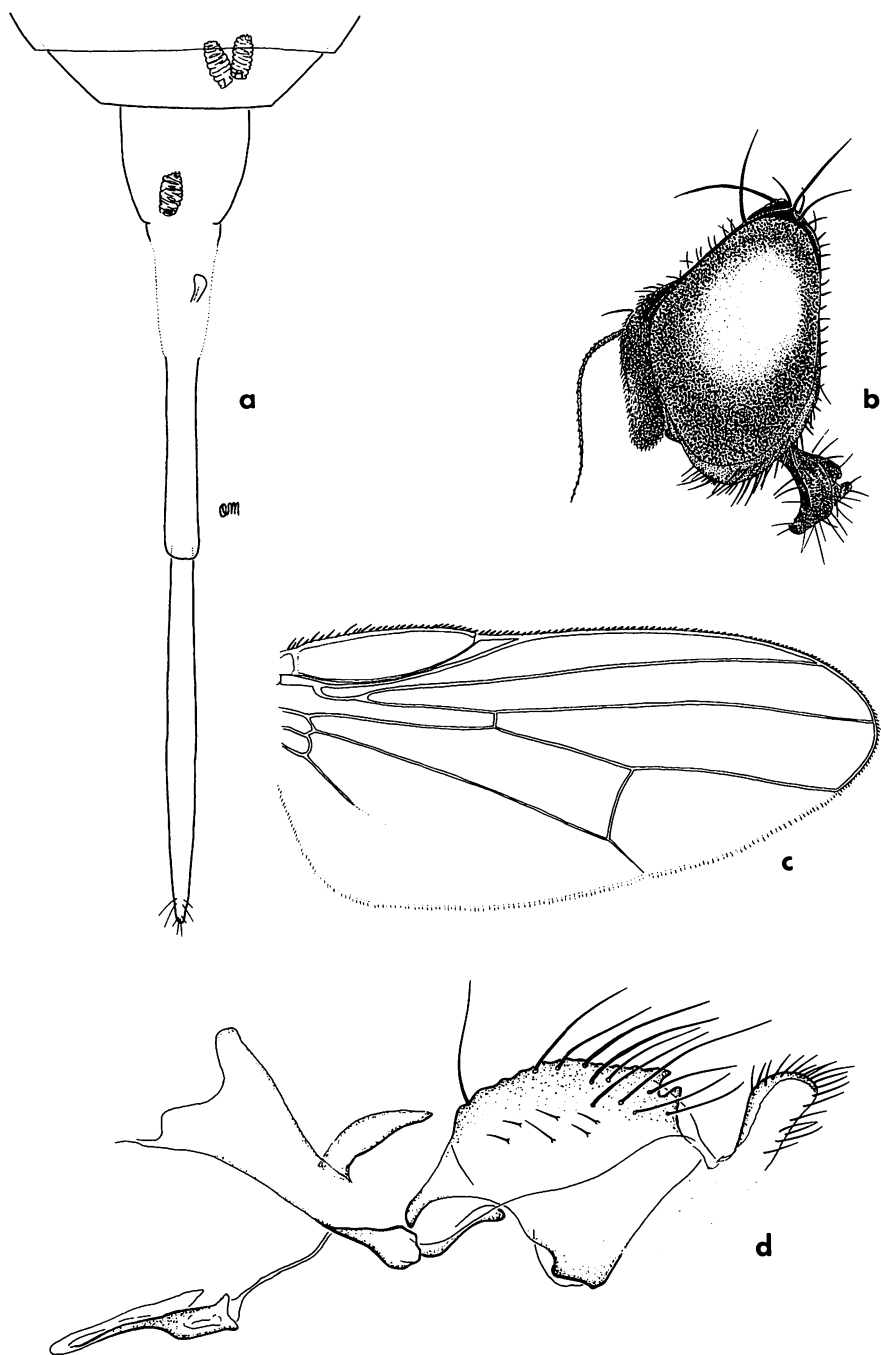


Figure 74—*Lonchaea polita* Say: a, female ovipositor; b, head; c, wing; d, male genitalia, lateral.

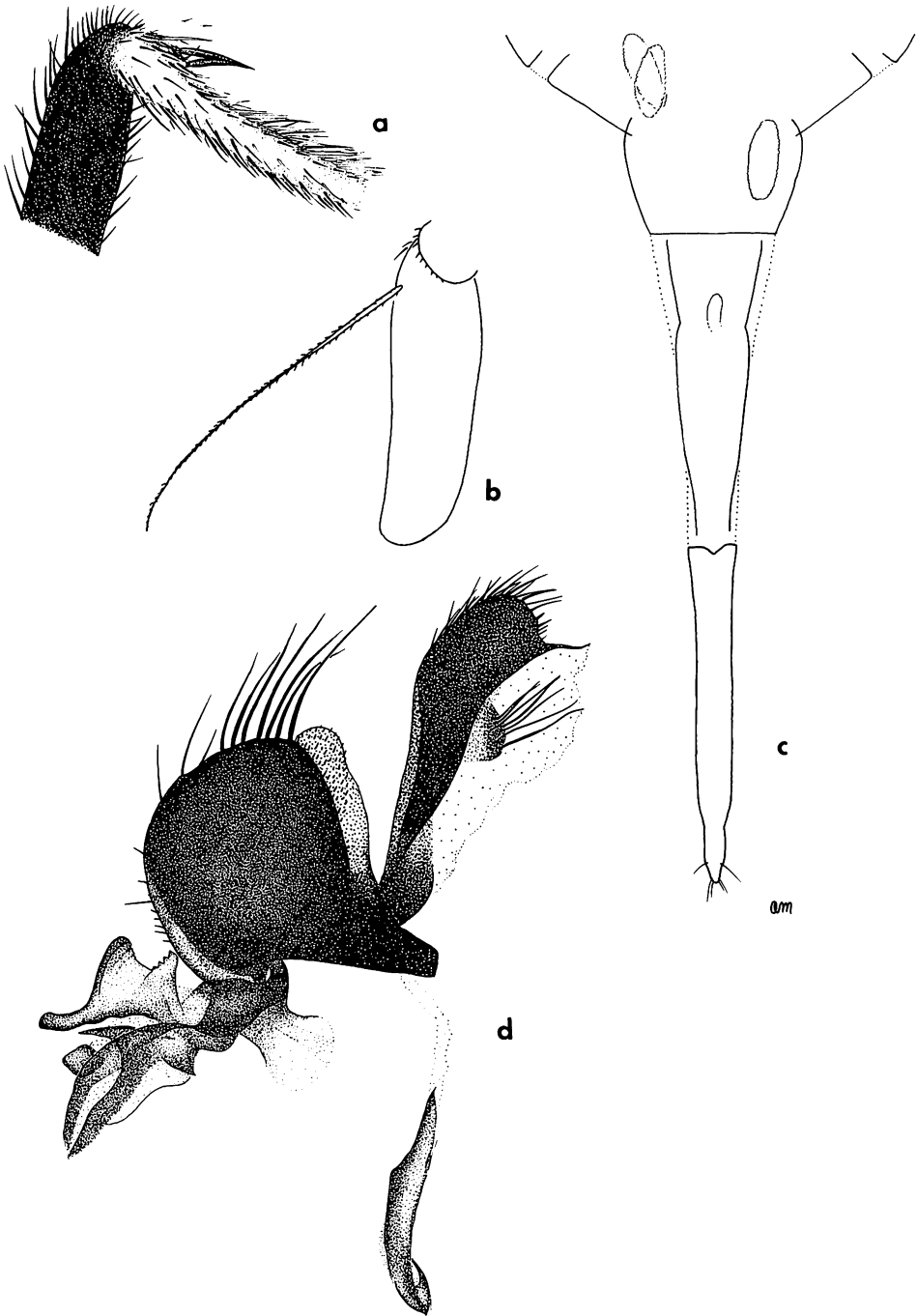


Figure 75—*Lonchaea striatifrons* Malloch: a, hind basitarsus of male; b, antenna; c, female ovipositor; d, male genitalia, lateral.

of posterior spines near base of hind basitarsus of male, shining black front, cercus of male elongate, extended into two hairy lobes as in figure 75d.

Front of male parallel-sided, nearly two times longer than wide. Face black, lightly grayish pubescent. Antennae black, except for a tinge of rufous at base of third. Third segment three times longer than wide, gray pubescent. Arista short pubescent. Legs black except for first two tarsomeres which are yellow. Hind basitarsus of male with a pair of yellow posterior spines near base (fig. 75a). Calyptrae long fringed, some of hairs in middle longer than the calyptrae. Wings similar to those of *polita*. Male with a row of prominent hairs along margin of epandrium and with cercus elongated and peculiar in development (fig. 75d). Female ovipositor and spermathecae as in figure 75c.

Length: body and wings, 4.0–4.5 mm.

Family PIOPHILIDAE

Rather small shiny black flies which somewhat resemble Sepsidae, but are readily differentiated by the all hyaline wing with the costa broken at or near the end of the subcostal vein and Sc ending near apex of vein R_1 (fig. 76a); mesonotum setulose; also by the abdomen not constricted basally; the palpi well developed; second antennal segment with a prominent erect dorsal bristle; metathoracic spiracle lacking long marginal hairs; as well as by other details. The resemblance is only superficial the two belong in distinctly different superfamilies.

These flies are scavengers in animal products.

For monographic studies refer to Melander and Spuler (1917), Melander (1924), and Hennig (1943).

Two species, belonging in two genera, are known from the Hawaiian Islands. They are differentiated by the following characters:

Only one pair of dorsocentral bristles. Gena approximately equal in height to eye (fig. 76b). Hind femora mostly black, hind tibiae broadly brown to black at apices. Mesopleuron lacking a dense patch of gray hairs. ***Piophila casei*** (Linnaeus).

Four pairs of dorsocentrals present. Eye about twice as high as gena (fig. 77a). Mid and hind legs entirely yellow. Mesopleuron densely gray pubescent over upper median portion.
. ***Protopiophila australis*** Harrison.

Genus **PIOPHILA** Fallén

Piophila Fallén, 1810, Spec. Ent. nov. Dipt.:20. Type-species, *Musca casei* Linnaeus, by monotypy.

Tyrophaga Kirby, in Kirby and Spence, 1826, Introd. Ent. 4:78. Type-species, *Musca casei* Linnaeus, by monotypy.

This genus is characterized by having no sternopleurals and only one pair of dorsocentral bristles (these are situated almost in line with the inner postalar bristles); also the calypteres well developed and densely fringed. Wings hyaline, veins yellow; crossvein r-m very short.

The typical subgenus is represented only by *P. casei*.

Piophilha casei (Linnaeus) (figs. 76a-e)

The Cheese Skipper

Musca putris var. *casei* Linnaeus, 1758, Syst. Nat. Ed. 10:597. Type-locality: Europe.

Piophilha pusilla Meigen, 1838, Syst. Besch. europ. zweifl. Ins. 7:360. Type-locality: Germany.

For other synonymy refer to Melander and Spuler (1917:69) and Hennig (1943:26).

On all the main Hawaiian Islands.

Immigrant. Cosmopolitan.

First reported in Hawaii by Grimshaw (1901:48). Collected August, 1892 at Kona, Hawaii.

In the past this species was commonly associated with cheeses and preserved meats. Today, with refrigeration and improved preservation, it is rarely found infesting foods, but breeds mainly on decomposing animal matter, around garbage accumulations and on carcasses, where it is involved in the final stages of cleanup of the bones. This species is well known in medical literature and has been a notorious domestic pest until recent times. Numerous cases of intestinal myiasis involving this species have been reported in the literature and there has been indication that these may produce serious intestinal lesions. It is probable that most of these reports are unconfirmed. It has been demonstrated that the larvae are able to pass through the alimentary alive, but they are not parasitic and it is doubtful that they cause more than temporary disturbance. Zumpt (1965:25) said "the larvae pass through the intestine as foreign bodies, causing more or less severe disturbance and even some tissue damage on the way, but they are not able to develop over a longer period, and are not to be regarded as true facultative parasites." According to James (1947:159) *P. casei* is the most common of insects found in the human intestine. Austin (1912) reported a case of nasal myiasis accompanied by profuse discharge and pain lasting several weeks and also a case of apparent myiasis of the respiratory tract in which larvae "were expectorated by a patient suffering from an infection of the chest." According to Zumpt (*loc. cit.*) "a case of urinary myiasis reported by Hilmy (1954) from Egypt remains to be confirmed." The larvae skip by bending the two ends of the body together and then suddenly straightening out.

Characterized by having the mesonotum minutely roughened and with three rows of short, inconspicuous setae; mesopleura with rather numerous short hairs; and genae broad, equal or wider than the eye (fig. 76b).

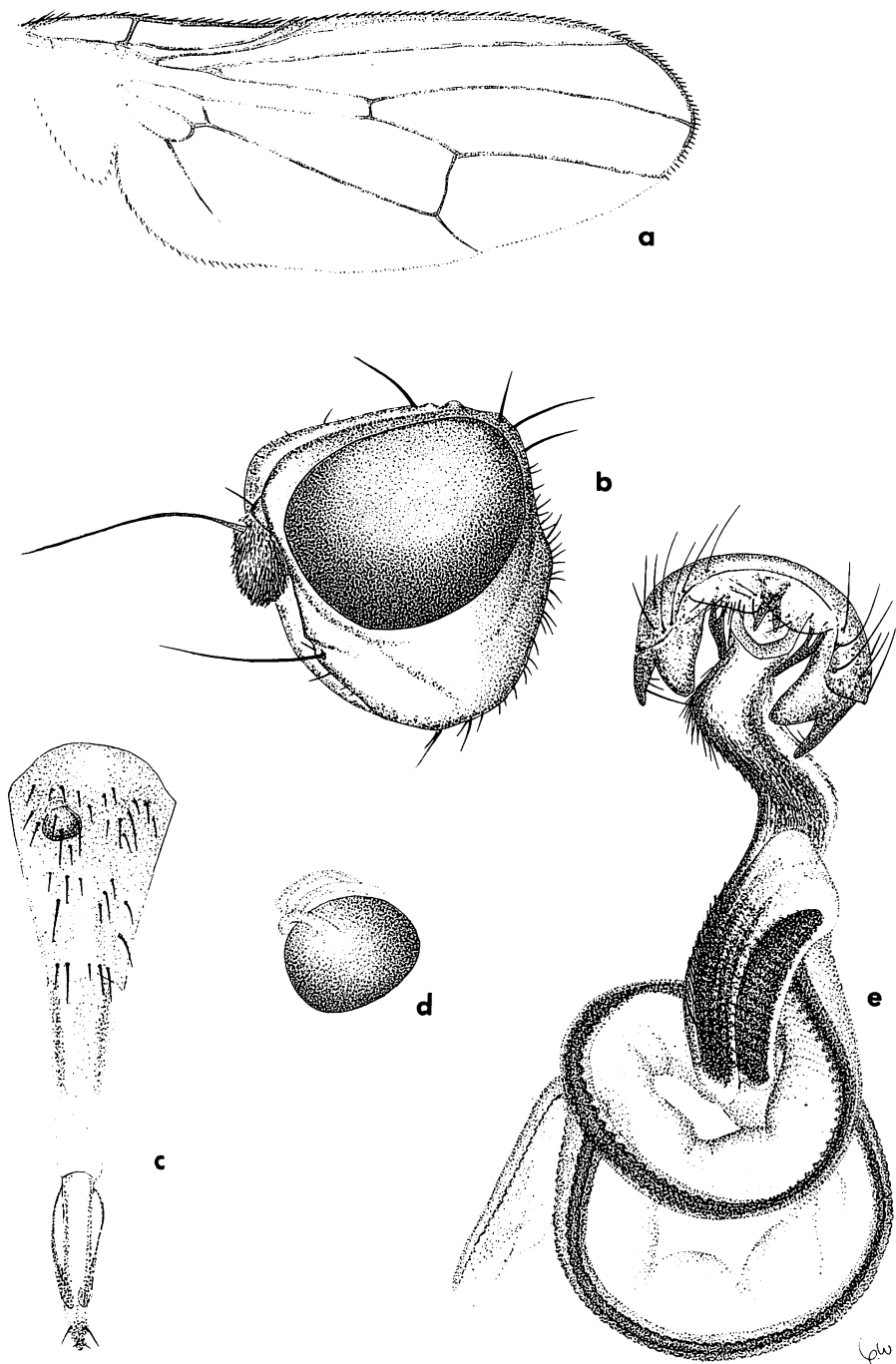


Figure 76—*Piophila casei* (Linnaeus): a, wing; b, head; c, female ovipositor; d, spermatheca; e, male genitalia.

Small shining black species, yellow on genae, face, lower front, coxae, trochanters, bases of femora, and tarsi. Head higher than long, shaped as in figure 76b with the eyes oval. One strong bristle on each side of oral margin on front edge of gena. No fronto-orbital bristles and ocellars subequal to postocellars. Second antennal segment with a short, black, dorsal bristle. Front basitarsus of male just slightly longer than tarsomeres two plus three. Wings as in figure 76a, the veins very pale. The genitalia of both sexes as in figures 76c, e. Male aedeagus long, strap-like and coiled, densely hairy on basal half and spiculose on apical half. Female with only one spermatheca; this is large, round and with a long coiled neck (fig. 76d).

Length: body and wings, 2.5–3.5 mm.

A detailed account of this species was given by Simmons (1927).

Genus **PROTOPIOPHILA** Duda

Piophila, subg. *Protopiophila* Duda, 1924, Konowia 3:109. Type-species, *Piophila latipes* Meigen, by monotypy.

Characterized by having four pairs of dorsocentral bristles.

Protopiophila australis Harrison (figs. 77a–b)

Protopiophila australis Harrison, 1959, N.Z. Dept. Sci. Ind. Res. Bull. 128:173, figs. 203, 207. Type-locality: Waitakere Range, New Zealand.

Oahu. First collected by Joaquin Tenorio, April 1971 on dead turtle shell, collected on Kahana beach, May 26, 1970 (Hardy, 1972).

Immigrant. Australia, Fiji, New Zealand.

The species is readily differentiated by the characters cited in the introduction. The original description is adequate except the genitalia have not been previously described. Harrison (1959) said that specimens from Australia and Fiji were previously determined by Malloch and by Bezzi as *Piophila contecta* Walker. He says it differs from *contecta* "chiefly by having hairs on the mesopleuron."

Head and body shining black except for gray pollinosity on face, propleura and around mesothoracic spiracle. Head shaped as in figure 77a. Third antennal segment nearly two times longer than wide, yellow, tinged with brown. Mesonotum densely covered with short, erect, black setae. One pair of presutural and three postsutural dorsocentrals. Halteres pale yellow. Front coxae, trochanters, and bases of femora pale yellow, also narrow apices of femora yellowish, front legs otherwise black. Wings as figured by Harrison (fig. 207, p. 177). Last section of $M_3 + 4$ about equal in length to the m cross-vein and r-m situated slightly beyond middle of cell 1st M_2 . Male genitalia as in figure 77b. The aedeagus is large, flattened, densely setose and coiled. The female ovipositor is elongate, the piercer is pale. Yellow, often visible *in situ* and with conspicuous preapical setae.

Length: body and wings, 2.75–3.25 mm.

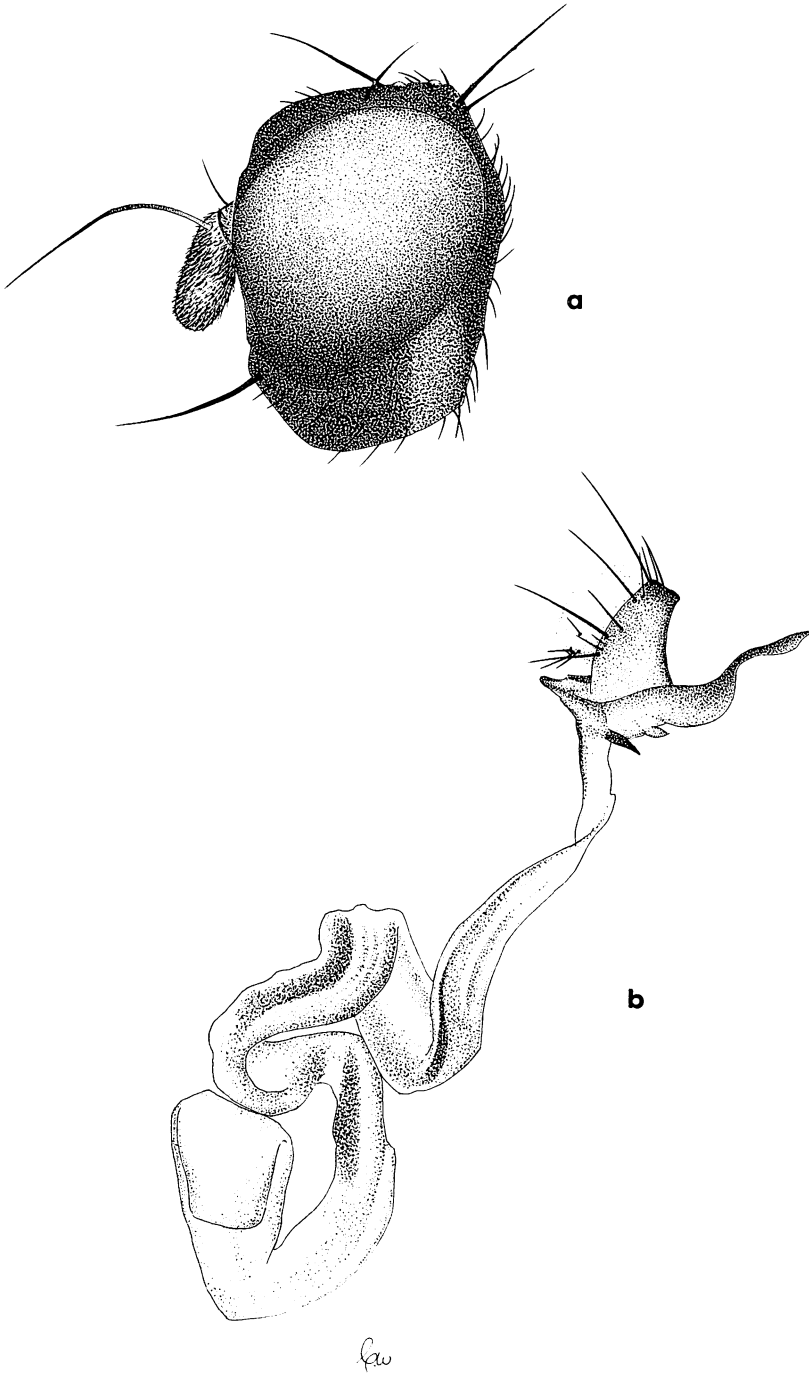


Figure 77—*Protopiophila australis* Harrison: a, head; b, male genitalia.

Family AGROMYZIDAE

The agromyzids are miners in living plants; many are of great economic importance attacking a wide assortment of agricultural crops and ornamental plants. According to Spencer (1969:26), "as many as 50 species of Agromyzidae attack cultivated plants, in a number of cases causing extensive damage and substantial economic loss. In Hawaii these flies cause extensive damage to beans, tomatoes, cabbages, squash, celery, asparagus, lettuce, etc. and attack a wide range of agricultural crops and ornamental plants." For species of economic importance, refer to Spencer (1973).

For a review of the habits and biologies of Agromyzidae, refer to Sasakawa (1960) and Spencer (1964a). As pointed out by Spencer (*op. cit.*:2), the majority of species are monophagous (restricted to feeding upon one plant species or closely related species within a genus) or at least oligophagous (feeding on several plant genera within a single family, or on closely related families of the same order). Truly polyphagous (feeding indiscriminately on a number of different plant orders) are extremely few. Apparently, the only polyphagous species in Hawaii is the stem boring *Melanagromyza virens* (Loew) (Compositae in Jamaica), Leguminosae, Cucurbitae, Umbellifera. This is the only known case of polyphagy in stem boring species. These are usually host specific. Also *Liriomyza brassicae* (Riley), a well known cosmopolitan species breeds on many genera of Cruciferae, Capparidaceae, and upon *Pisum sativum* L. (Leguminosae).

Hymenopterous parasites are important in keeping populations of leaf miners in check. To date, approximately a dozen species of parasites have been reared from agromyzids in Hawaii. Many of these are obviously polyphagous and attack a number of different species. The actual effect of these parasites as biological control agents has never been assessed in Hawaii, but it seems evident that the use of chemicals may often be doing more harm than good. Leaf miners consistently cause considerable damage to beans; tomatoes, eggplants, and other crops despite chemical control programs.

Types of damage in Hawaii

Serpentine mines	<i>Liriomyza</i> spp. <i>Ophiomyia</i> spp.
Linear mines	<i>Phytomyza plantaginis</i> R.D. <i>Pseudonapomyza spicata</i> (Malloch)
Blotch mines	<i>Amauromyza maculosa</i> (Malloch) <i>Calycomyza humeralis</i> (Roser)
Stem miners or borers	<i>Melanagromyza</i> <i>Phytoliriomyza montana</i> Frick prob. stem miner <i>Ophiomyia simplex</i> Loew
Flowers—feeding on receptacle on <i>Lantana</i>	<i>Ophiomyia lantanae</i> (Frogg.)

Spencer (1963:133) said "the family Agromyzidae has been studied more thoroughly than any other family of the acalyptrate Diptera. This is accounted for, in part, by the ease in which the adults are bred from immature stages from their conspicuous leaf mines, which aroused much interest among early biologists." The systematic revision by Nowakowski (1962) is extremely important in gaining a basic understanding of these flies. This study laid the groundwork for the modern classification of the family.

The Agromyzidae are differentiated from related families of Acalyptratae, which have the costa broken only at end of subcostal vein, cells M and Cu present, with distinct oral vibrissae, subcostal vein incomplete or vestigial, and tibiae lacking preapical dorsal bristles by having the postocellar bristles widely divergent, three to five (in Hawaiian species) pairs of fronto-orbital bristles, with the inferior fronto-orbitals usually directed inwards and the superior fronto-orbitals inclined upwards or slightly outwards, and seventh segment of female abdomen heavily sclerotized, tubular and non-retractile.

Small, mostly black, often marked with yellow; body length (Hawaiian species), 1.25–3.3 mm. Third antennal segment short, rounded, aristae pubescent. Vertical plates on front continuous with parafacial plates and genal plates. Antennae slightly separated at bases, with a small carina between which extends longitudinally as a raised area down middle of face. Chaetotaxy of thorax variable, depending upon genus. Wings hyaline, venation as in figures 85a, 86a, 91b. Subcosta developed throughout its length and joining with R_1 before its apex (fig. 78a) in subfamily Agromyzinae; or the Sc evanesces and becomes a fold or a very faint vein ending in the costa free of R_1 (fig. 78b) in subfamily Phytomyzinae. Genitalia of both sexes as in figures 80a, 84a, 89a, 90c. For genitalia refer to Sasakawa 1958 (females) and 1961:320 (males).

For morphological and biological details refer to Frick (1952a:343–354).

The larvae form characteristic feeding patterns on the plant and the mines are often diagnostic for given species. In most species the larvae feed in the upper layer of cells of the leaf, immediately below the epidermis in the palisade parenchyma. These mines may be linear, serpentine, or of large blotch type and are readily seen from surface of the leaf. Spencer (1969:11) discusses several other types of mines caused by agromyzids, including those which penetrate into the lower cells of the spongy parenchyma and are often invisible and extremely difficult to detect. Study of leaf miners was the principal interest of Dr. E. M. Hering; he devoted most of his life to this study and published a large number of papers on the subject. Kenneth A. Spencer, the leading authority on the systematics of this family, was a long-time friend of Dr. Hering and obtained his interest in the Agromyzidae when he translated into English the manuscript for Hering's *Biology of the Leaf Miners* (1951).

Eight genera and 17 species belonging in two subfamilies are now known from the Hawaiian Islands. The earlier literature dealing with agromyzids in Hawaii was almost totally confused; previous to 1952 only the name *Ophiomyia lantanae* (Froggatt) is valid. Only *Phytoliriomyza montana* appears to be endemic,

- Costa ending at apex of vein $R_4 + 5$ (fig. 91b). Third antennal segment pointed above at apex. Crossvein m apparently absent, or situated basad of r-m and appearing as base of $M_3 + 4$. Leaf miners in corn, sugarcane and other Gramineae. **Pseudonapomyza** Hendel.
5. Scutellum dark brown to black, concolorous with mesonotum, pleura and legs usually dark brown. 7
Scutellum (in *cocculi* faintly tinged with brown), pleura, and usually legs pale yellow. Vein $M_1 + 2$ ends at wing apex. Serpentine leaf miners. **Liriomyza** Mik.
6. Costa extending only to tip of vein $R_4 + 5$. Crossvein m lacking. **Phytomyza** Fallén.
(*plantaginis* R-D).
Costa extending to $M_1 + 2$. Crossvein m present. **Phytoliriomyza** Hendel.
(*montana* Frick).
7. Knobs of halteres white or yellowish. Four pairs of fronto-orbital bristles. Last section of vein $M_3 + 4$ three to four times longer than penultimate section (fig. 86b). Posterior acrostichal setae not enlarged. **Calycomyza** Hendel.
Halteres with a black spot at apex. Last section of $M_3 + 4$ about equal to penultimate section (fig. 85a). Five to six pairs of fronto-orbitals (three to four pairs of inferior fronto-orbitals) with a pair of large, bristle-like acrostichals in line with posterior dorsocentral bristles. Distiphallus with numerous spinules (fig. 85c). . . **Amauromyza** Hendel.
(*maculosa* [Malloch]).

Subfamily AGROMYZINAE

Differentiated by having the subcostal vein well developed but coalescing with vein R_1 before reaching costa. Vein R_1 broadened at point of junction with Sc and costa indented at apex of R_1 (fig. 78a). Also, according to Frick (1952a:368), "mouthparts with galea elongate and without premental basal projections; male terminalia with postgonites [lobes of hypandrium-ninth sternum] consisting of broad flattened plates, elongate longitudinally, never vertical, not projecting ventrally, or projecting slightly and then broadly reniform and without teeth; wings, when at rest, only partly folded over dorsum of abdomen, never folded completely, one above the other."

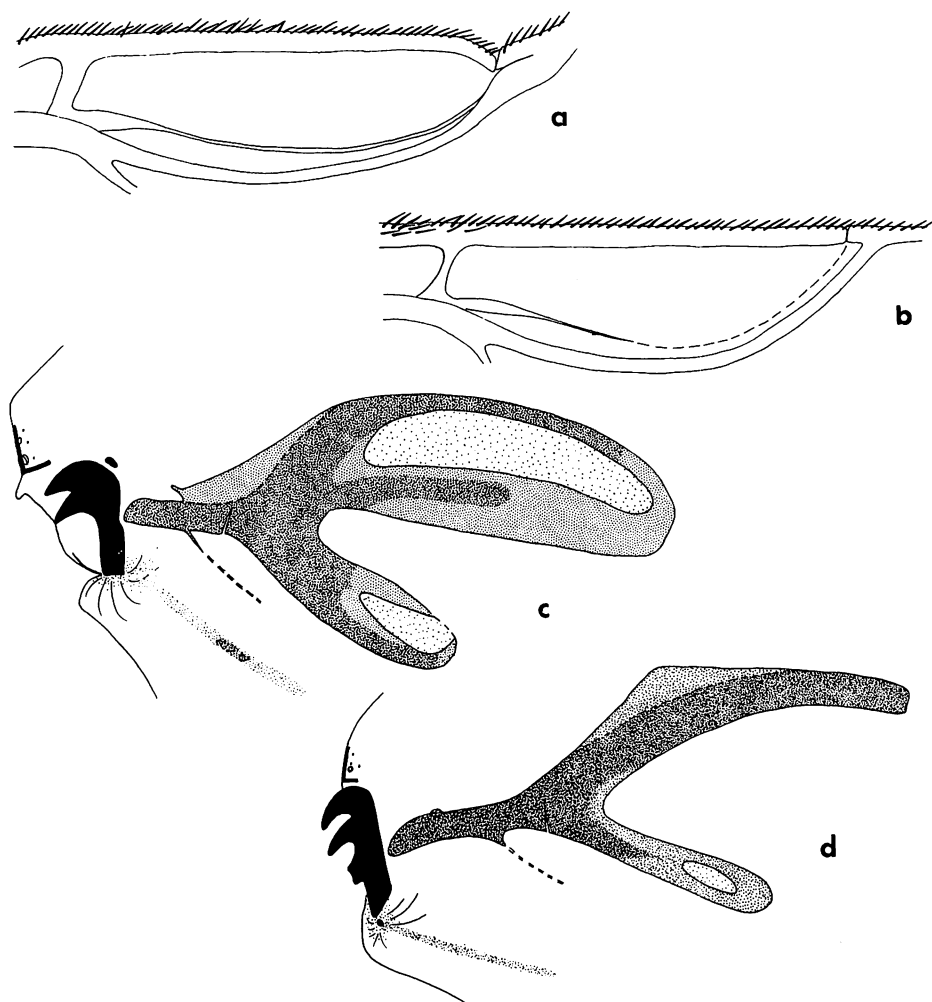


Figure 78—*Agromyza ambigua* Fallén: a, anterobasal section of wing. *Napomyza lateralis* (Fallén): b, same as a. *Agromyza reptans* Fallén: c, cephalopharyngeal skeleton, mouth hooks, and head of larva. *Phytomyza atricornis* Meigen: d, same as c.

Larva: Paraclypeal phragma of cephalopharyngeal apparatus broadened dorsally; heavily sclerotized dorsal and ventral arms either visibly meeting or approximate posteriorly'' (fig. 78c).

Only two genera occur in Hawaii: *Melanagromyza* Hendel and *Ophiomyia* Braschnikov.

Genus **MELANAGROMYZA** Hendel

Melanagromyza Hendel, 1920, Arch. Naturgesch. (A) 84:126. Type-species, *Agromyza aeneoventris* Fallén, by original designation.

Limnoagromyza Malloch, 1921, Bull. Brooklyn ent. Soc. (1920) 15:147. Type-species, *diantherae* Malloch, by original designation.

Members of this genus are predominantly stem borers and are among the most destructive of the family. Most species are host specific. The adults are uniformly black, with a metallic sheen on the mesonotum and abdomen. They are characterized by having the halteres brown or black; two pairs of dorsocentral bristles; carina between bases of antennae flat, narrow, straight-sided; prescutellar bristles lacking; costa extending to apex of vein $M_1 + 2$; and male never with a vibrissal horn. According to Spencer (1966a:5) the male genitalia are characterized by having the basiphallus U-shaped, and the larvae are differentiated by having numerous bulbs, from 6 to 20, on the posterior spiracles, "normally surrounding a strong black horn (rarely atrophied to a mere scar)."

Spencer (1963a:144) stated "the size ranges from minute epidermal leaf miners with a wing length of 1.5 mm. to stem borers with a wing length of up to 3.5 mm. The adults in many groups are extremely difficult to distinguish; the larvae or puparia, however, frequently reveal striking differences in closely related species."

Because of the external similarities in the adults of *Melanagromyza* and *Ophiomyia*, the species are being treated together in one key.

Only one species of *Melanagromyza* occurs in Hawaii.

KEY TO SPECIES OF MELANAGROMYZA AND OPHIOMYIA RECOGNIZED FROM HAWAII

1. Males with jowls (front margins of genae) conspicuously produced forwards and a prominent horn-like vibrissal fasciculus on each side (fig. 81b). Carina between antennae prominent, spindle-shaped, gibbose in middle (fig. 81a). 2
 Genae not produced forwards, rounded, and no fasciculus present. Carina not prominent, narrow, straight-sided (fig. 78a). 4
2. Squamal fringe dark brown to black. 3
 Squamal fringe white.
 ***Ophiomyia cornuta*** (de Meijere).
3. Abdomen faintly metallic green. Carina between antennae scarcely bulbous. Distophallus of male spinulose distally (fig. 82a). Larva with a dorsoapical clavate process on head (fig. 82b). Miner in the stems of *Verbena*.
 ***Ophiomyia nealae*** Sasakawa.
 Abdomen metallic black in ground color. Carina conspicuously bulbous (fig. 81a). Distophallus of

male not distinctly spinulose distally (fig. 81c), although with minute spicules, as seen under high power. Larva lacking a clavate process on head. Larvae feed in the fleshy receptacles of the flowers of *Lantana* **Ophiomyia lantanae** (Froggatt).

4. Eyes bare. Squamal fringes dark, smoky brown to black. Crossvein r-m situated near apex of cell 1st M_2 ; penultimate section of vein $M_1 + 2$ shorter than m crossvein (figs. 83a, 84b). Abdomen metallic black. 5
 Eyes short pilose in male, especially above. Squamal fringes white. Crossvein r-m at about apical two-thirds of cell 1st M_2 and penultimate section of $M_1 + 2$ nearly equal to length of m crossvein (fig. 79b). Abdomen with a coppery sheen in ground color. Stem miner in Compositae.
 **Melanagromyza splendida** Frick.
5. Ocellar triangle very large, polished black, extending almost full length, and occupying median third, of front. Penultimate section of vein $M_1 + 2$ over two times longer than r-m crossvein (fig. 83a). Stem miner in beans and other leguminous crops. **Ophiomyia phaseoli** (Tryon).
 Ocellar triangle short, not extended beyond level with lower superior fronto-orbital bristles. Penultimate section of vein $M_1 + 2$ scarcely longer than r-m (fig. 84b). Stem miner in *Asparagus*.
 **Ophiomyia simplex** (Loew).

Melanagromyza splendida Frick (figs. 79a-b)

Melanagromyza splendida Frick, 1953, Proc. Haw. ent. Soc. 15:207. Type-locality: Kamuela, Hawaii.

Melanagromyza sp.? Frick.

Hawaii, Oahu, Maui, Kauai.

Immigrant. First described from Hawaii but subsequently (Spencer, 1969:78) recorded from Jamaica, Florida, and California.

Hosts: Larvae feed as internal stem borers in Compositae. In Hawaii they have been reported doing serious damage to celery plantings; they mine extensively up and down the stems and may transmit a rot disease. It has also been reared from lettuce, safflower, *Gnaphalium*, *Bidens*, *Zinnia*, and cocklebur (*Xanthium*). Spencer (1969:78) recorded it from *Flaveria linearis*, in Florida, and *Helianthus*, in California. Specimens are in collections labeled sweet potatoes and squash; these may have been just collected on these plants.

Parasites: *Habrocytus* sp. (ref. Krauss, 1963:217, under *M. virens*) and *Heteroschema* sp.

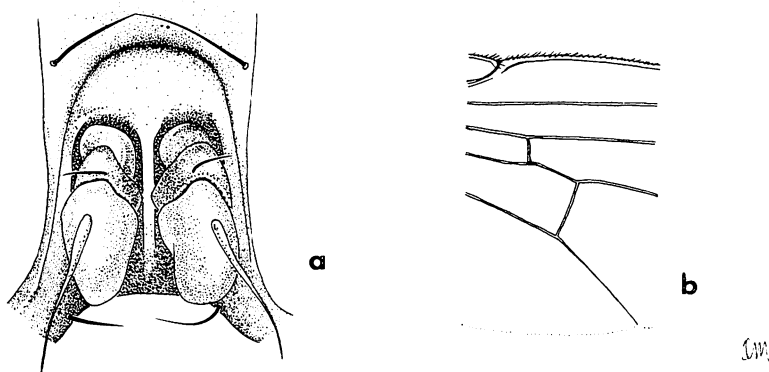


Figure 79—*Melanagromyza splendida* Frick: a, front of head, showing facial keel; b, middle section of wing.

The references to *M. virens* (Loew) in the Hawaiian literature (Hardy, 1956; Beardsley, 1963; and Krauss, 1963) pertain to *splendida*. Also the reference *Agromyza simplex* Loew, by Hardy (1951) reared from celery and *Melanagromyza* sp.?, from celery (Hardy, 1952a:475) pertains to *splendida*.

Spencer (1963b:322) has previously considered this a synonym of *virens* (Loew), but recently (1969:76) has decided that these are distinct species. Spencer says "the characteristic features of *M. virens* are the exceptionally broad orbits bearing numerous rows of setulae, with the above conspicuously proclinate." In *splendida* the orbits are also broader than average and the general arrangement of the orbital setulae is as in *virens*, but they are noticeably sparser and less distinctly proclinate above and in the inner rows.

The species is differentiated from the other species of *Melanagromyza* recognized in Hawaii by the pilose eyes of the male, the all white squamae, the coppery or greenish sheen in the ground color of the abdomen, and the longer penultimate section of vein $M_1 + 2$ (fig. 79b).

Mostly shining black flies with front opaque brown to black, subshining on orbits and with ocellar triangle subshining and extending one-half to about three-fifths the distance to lunule. Two pairs of incurved inferior fronto-orbital bristles and two pairs reclinate superior fronto-orbitals. Genae rounded, about one seventh as wide as eye height. Facial keel as in figure 79a. Arista microscopically pubescent. Mesonotum with two pairs of dorsocentral bristles. Squamae entirely white. Middle tibiae each with a pair of short posterior bristles near middle. Penultimate section of vein $M_1 + 2$ about three times longer than r-m and nearly as long as m crossvein (fig. 79b).

Length: body and wings, 2.50–3.25 mm.

Genus **OPHIOMYIA** Braschnikov

Agromyza, subg. *Ophiomyia* Braschnikov, 1897, Moskva Selsk. Khoz, Inst, Isv. 3(pl. 2):40. Type-species, *Agromyza pulicaria* Meigen, by monotypy, misidentification, = *maura* (Meigen).

As discussed under *Melanagromyza* these genera are homogeneous, very much alike externally and, in some species, positive identification is possible only by male genital characters and by characteristics of the larvae and puparia; the arrangement of the posterior spiracles of the larvae is apparently the most reliable character for differentiating many of the species.

Spencer (1964b) revised the Palaearctic species and differentiates *Ophiomyia* by "antennae normally separated by distinctly raised facial keel; male normally with vibrissal fasciculus, if neither character is present male genitalia distinctive, with basiphallus elongate with two distinct sidearms and a strongly chitinized base; larva with posterior spiracles on two raised stalks (pulicaria group)."

Four (possibly five) species are known to be established in Hawaii and one other species is widespread over the Pacific, breeding in *Scaevola*, and is probably in Hawaii. In all, except *simplex* (Loew), the lower sides of face above oral margin (jowls) are produced, and the vibrissae are clumped together into a conspicuous fascicule or curving horn-like process (fig. 81b). In these same species the carina between the antennae is well developed, spindle-shaped, narrowed above and below, and gibbose in the middle (fig. 81a); also, they are rather dull black, less metallic, or shining on the mesonotum and abdomen. *O. simplex* fits in an entirely different group and was treated under *Melanagromyza* until Spencer (1966a:55) discovered that, because of the characteristics of the male genitalia and the larvae, this belongs in *Ophiomyia*.

The species are being keyed with *Melanagromyza*; see under that genus.

***Ophiomyia cornuta* (de Meijere) (figs. 80a-b)**

Agromyza cornuta de Meijere, 1910, Tijdschr. Ent. 53:161. Type-locality: Krakatau, Indonesia.

Ophiomyia leucolepsis Bezzi, 1928, Dipt. Brachycera, Fiji:164. Type-locality: Galalai, Fiji.

Ophiomyia scaevolae Frick, 1953, Proc. Trans. Ent. Soc. 15:209. Type-locality: Canton Island.

Immigrant. Widespread throughout the Pacific, Indonesia, and the Indian Ocean. It has been recorded from Canton Island and is possibly present in Hawaii.

Hosts: The larvae mine the leaves of *Scaecola frutescens* (Mill.) and *S. koenigii* Vall.

This species has not been reported in Hawaii to date, but since it breeds commonly on *Scaevola* throughout much of the Pacific, the possibility is good that it will become established, if it is not already here.

It is readily differentiated from other small, all black agromyzids in Hawaii by the prominent vibrissal fasciculae in the male in combination with the all white squamae. In other Hawaiian *Ophiomyia* the squamal fringe is dark colored.

The genitalia are as in figures 80a, b.

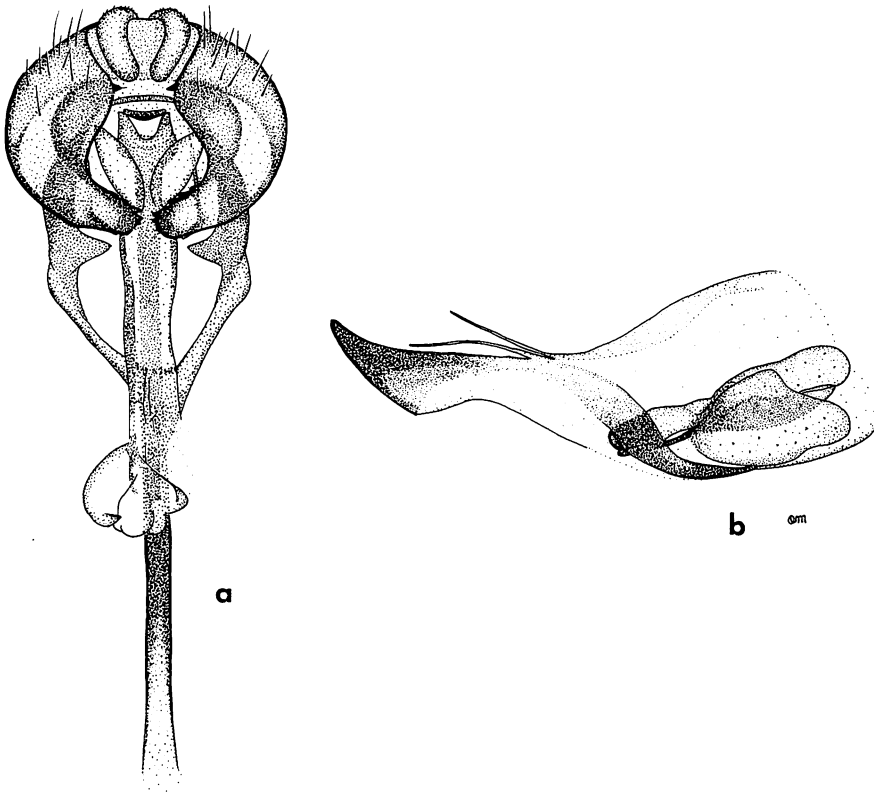


Figure 80—*Ophiomyia cornuta* (de Meijere): a, male genitalia, ventral; b, aedeagus.

***Ophiomyia lantanae* (Froggatt) (figs. 81a-c)**

Agromyza lantanae Froggatt, 1919, Agric. Gaz. N.S.W. 30:665. Type-locality: Australia.

Common in the lowlands throughout the Hawaiian Islands. Purposely introduced from Mexico in 1902 to aid in control of *Lantana camara* L. (Perkins and Swezey, 1925).

Immigrant. Widespread throughout the Orient, Australia, Africa, Southern U.S., Mexico, Central America and West Indies, Caroline Islands, Fiji, and Hawaii.

Host and biology: The larvae have been commonly reported as seed feeders on various species of *Lantana*, but, as recorded by Spencer (1963a:156 and 1963c:324), "the larva feeds in the receptacle of the flower-head and also in the fleshy part of the fruit surrounding individual seeds." Spencer indicates that the seeds are not normally damaged and questions the effectiveness of this fly in controlling *Lantana*.

Parasites: Bridwell (1919:170) stated that it is parasitized by *Opius lantanae*

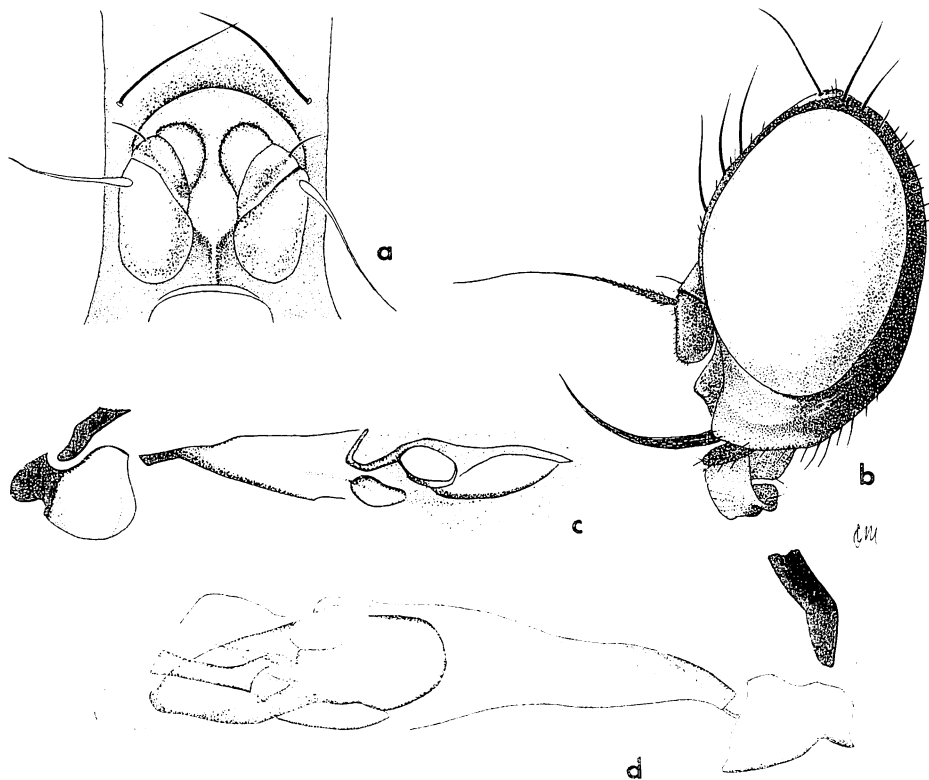


Figure 81—*Ophiomyia lantanae* (Froggatt): a, frontal view of head; b, head, lateral; c, aedeagus (copied from Spencer, 1963c:349, fig. 34a). *Ophiomyia* n. sp., Sehgal: d, aedeagus.

Bridwell and Timberlake (1924:361, 422) said it is probably parasitized by the pteromalid *Zatropis tortricidis* Crawford.

The species is differentiated by having the squamal fringe dark colored, brown to black; a conspicuous bulbous keel separating bases of antennae (fig. 81a); a strong vibrissal horn in the male (fig. 81b); the abdomen metallic black; distophallus of male not distinctly spinulose distally (fig. 81c); and larvae lacking a clavate process on head. In specimens of *lantanae* that we have examined the distophallus is covered with minute spicules, as seen under high power.

***Ophiomyia nealae* Sasakawa (figs. 82a-e)**

Ophiomyia nealae Sasakawa, 1964, Proc. Haw. Ent. Soc. 18:425. Type-locality: Tantalus, Oahu. Holotype male in B. P. Bishop Museum.

Endemic. Oahu.

Host. According to Sasakawa (1964:427) the larva makes a whitish ophionome on stem of *Verbena literalis* H.B.K.

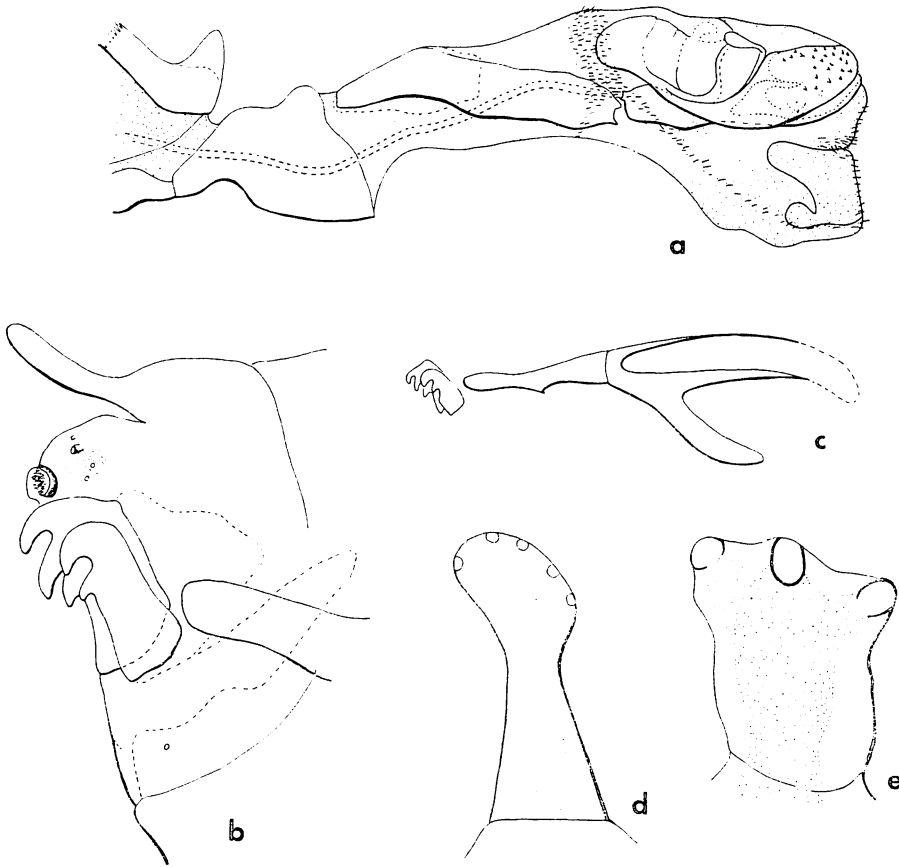


Figure 82—*Ophiomyia nealae* Sasakawa: a, aedeagus, lateral; b-e, larva (b, head, lateral; c, cephalopharyngeal skeleton; d, anterior spiracle; e, posterior spiracle) (all copied from Sasakawa, 1964b:426, fig. 1).

Differentiated from *lantanae* by the faint metallic green tinge on the abdomen; having the carina between the antenna less distinctly bulbous; and by having the distophallus of the male spinulose distally (fig. 82a). Also, the larva has a clavate process on the apicodorsal portion of the head (fig. 82b). For a detailed description refer to the original description.

***Ophiomyia phaseoli* (Tryon) (figs. 83a-b)**
Bean Fly

Oscinis phaseoli Tryon, 1895, Trans. Nat. Hist. Soc. Queensland 1:4-7.
Type-locality: Australia. *Agromyza destructor* Malloch, 1916, Proc. Ent. Soc. Wash. 18:93. Type-locality: Los Baños, Laguna, Philippines.

Oahu, Kauai, Maui, Molokai, Hawaii. First reported in the state of Hawaii

in June 1968 at Waiahole, Oahu; and by December 1968 it had spread to all of the main islands (Davis, 1969) and is a serious pest of beans.

Immigrant. An exclusively tropical or subtropical species occurring from Africa, throughout southern Asia to northern Australia, and throughout much of the Pacific.

Hosts: According to Spencer (1963:150, 1969:27) *phaseoli* is probably the most destructive species of agromyzid. It is a serious pest of a wide variety of leguminous crops and has been recorded mining the following genera: *Cajanus*, *Canavalia*, *Crotalaria*, *Dolichos*, *Phaseolus*, *Soja*, and *Vigna*.

Parasites: Two species of Braconidae, *Opius phaseoli* Fischer and *O. importatus* Fischer, are important parasites of this fly (Funasaki, 1971). These were previously reported in our literature as *Opius* sp. probably *melanagromyzae* and *Opius* sp. (Au, 1969). The pteromalid wasp *Halticoptera patellana* (Dalm) has also been reared from this species (Chong, 1969).

Oviposition occurs in the leaves and the first instar larvae form a short linear mine into the stem where the main development and principal damage occurs. In heavy infestations, the feeding of many larvae in the stems causes them to turn brown and break open and the plant dies. The puparia remain inside the stems.

The biology has been dealt with in detail by Otones (1918).

According to V. K. Sehgal (in press), because of the structure of the male genitalia (the elongate basiphallus of the aedeagus), this species properly fits in *Ophiomyia*. Spencer (pers. comm.) agrees with this placement.

Readily differentiated from other *Ophiomyia* by the very large, polished black ocellar triangle. This is very elongate and extends almost the full length of the front. Also differentiated by the structure of the male aedeagus (fig. 83b).

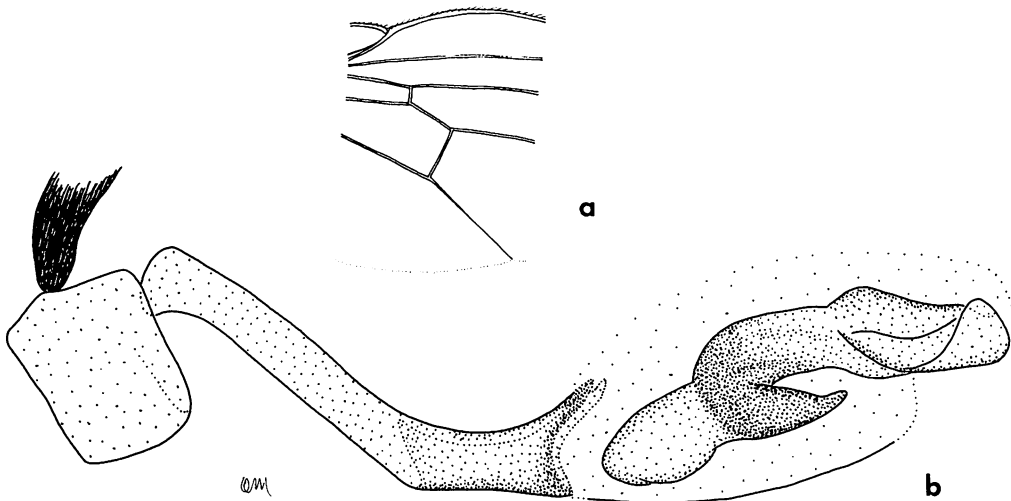


Figure 83—*Ophiomyia phaseoli* (Tryon): a, middle section of wing; b, aedeagus.

Front rather narrow, not as wide as eye. Two pairs each of inferior and superior fronto-orbital bristles, the latter slightly stronger. Arista microscopically pubescent. Genae rather broad, rounded, about one-seventh as high as eye. Mesonotum and abdomen metallic black. Penultimate section of vein $M_1 + 2$ two-thirds to three-fourths as long as m crossvein and nearly three times longer than r-m (fig. 83a).

Length: body and wings, 2.0-2.2 mm.

***Ophiomyia simplex* (Loew) (figs. 84a-c)**

Agromyza simplex Loew, 1869, Berl. Ent. Z. 13:46. Type-locality: Pennsylvania, U.S.A.

Oahu.

Immigrant. Widespread over North America and Europe. First reported in Hawaii in an asparagus field May 1937 (Swezey, 1938), and subsequently reported causing extensive damage to asparagus (Bianchi, 1941). The species recorded as *Agromyza simplex*, on celery (Hardy, 1951), was *Melanagromyza splendida* Frick.

Hosts: Restricted to *Asparagus*. The larvae mine under the epidermis of

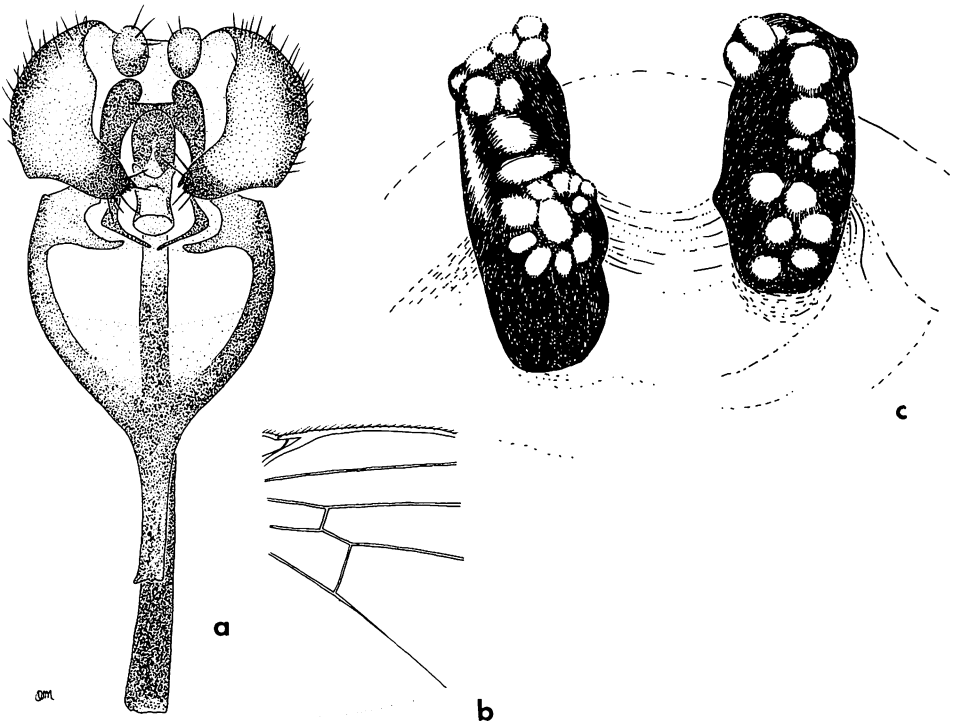


Figure 84—*Ophiomyia simplex* (Loew): a, male genitalia, ventral; b, middle section of wing; c, posterior spiracles on puparium (the latter copied from Spencer, 1966a:54, fig. 88).

asparagus stems close to the ground level and cause a rapid breakdown of the tissues, making the infested stalks unsalable.

Parasites: An aphelinid wasp, apparently *Centrodora xiphidii* (Perkins), was reared by Bianchi (1941).

Frick (1959:366) says *simplex* is distinct from *similata* by the shining genovertical plates and by having 8–10 rows of acrostichal setae.

Spencer (1966a:55–56) gives the following description: "Adult: wing length from 2.2 mm. in male to 3 mm. in female, costa ending at or shortly behind vein $r_4 + 5$ [$R_4 + 5$], last and penultimate sections of m_4 [$M_3 + 4$] approximately equal; frons broad, almost twice width of eye, orbits conspicuously shining and distinctly projecting above eye in profile; normally five strong orbital bristles, orbital setulae strong, reclinate; jowls broad, almost quarter height of eye, cheeks forming broad ring below eye; mesonotum and abdomen entirely shining black, squamae gray, margin and fringe black." He states that the aedeagus of the male has the "basiphallus with elongated side arms typical of the genus." Genitalia seen from ventral view as in figure 84a.

The immature stages and biology have been discussed in detail by Barnes (1937). The puparium is dark reddish brown. The posterior spiracles are on two raised tubercles; each bears about 16 irregular bulbs arranged in a semi-circle (fig. 84c).

Ophiomyia, new species (fig. 81d)

Dr. V. K. Sehgal has sent us a copy of a manuscript in which he is describing a new species of *Ophiomyia* from the Waianae coast of Oahu. He states that this differs from *O. lantanae* (Froggatt) and *nealae* Sasakawa "in having deeper genae and distinctive genitalia." He further states that "the main distinguishing characters are dark brown squamal fringe, gena one-fourth to one-fifth eye height, facial keel bulbous, vibrissal angle about 80° , strong upcurved vibrissal fasciculus in male, and a distinctive aedeagus." We see no differences from the above in *lantanae*, but are not certain of the interpretation of the distophallus characters so we are referring to a copy of a drawing by Sehgal (fig. 81d) to represent his "new species" and one of Spencer's (1963c:349, fig. 34A) to represent *lantanae* (fig. 81c).

Subfamily PHYTOMYZINAE

Differentiated by having the Sc not joined with R_1 , extending to costa as a faint vein or a fold; apex of R_1 not thickened and no indentation on costa (fig. 78b). Frick (1952a:385) also says, "mouth parts with galea rudimentary and with premental basal projections present; male terminalia with postgonites vertical, strongly elongate vertically, terminating ventrally with teeth, or smoothly and narrowly rounded; wings, when at rest, usually folded one above the other over the abdomen.

Larva: Paraclypeal phragma of cephalopharyngeal apparatus relatively narrow; dorsal arm nearly straight; ventral arm usually very weakly developed

and sclerotized for only a short distance from base, rarely elongate, if so then very slender (fig. 78d).

The following six genera are known from Hawaii: *Amauromyza* Hendel, *Calycomyza* Hendel, *Liriomyza* Mik, *Phytoliriomyza* Hendel, *Phytomyza* Fallén, and *Pseudonapomyza* Hendel.

Genus **AMAUROMYZA** Hendel

Dizygomyza, subg. *Amauromyza* Hendel, 1931, in Lindner, Die Flieg. palaeark. Reg. 6:59. Type-species, *Agromyza lamii* Kaltenbach, by original designation.

Dizygomyza, subg. *Cephalomyza* Hendel, 1931, in Lindner, Die Flieg. palaeark. Reg. 6:32. Type-species, *Dizygomyza luteiceps* Hendel.

The Hawaiian species is differentiated by being entirely black with the halteres white, except for a prominent black spot on upper apex; front with three or four pairs of inferior fronto-orbital bristles and mesonotum with a pair of strong bristle-like acrostichals in line with the posterior dorsocentrals. Also, according to Spencer (1969:28), characterized by having numerous spinules on distophallus.

This was raised to generic rank by Nowakowski (1962:97).

Only one species known from Hawaii.

Amauromyza maculosa (Malloch) (figs. 85a-c)

Agromyza maculosa Malloch, 1913, Ann. Ent. Soc. Amer. 6:302. Type-locality: New York, U.S.A.

Oahu, Hawaii, Lanai, Molokai, Kauai. Probably on all the main islands. First reported in Hawaii May, 1956 (Hardy, 1957), as *Phytobia*.

Immigrant. Widespread over North America and Neotropical region.

Hosts: The larvae form blotch type mines in the leaves of various plants. In Hawaii it has been reared from numerous species of Compositae and may be restricted to this plant family. Specimens are in the collection, however, labeled "mining sweet potato leaf," Honolulu, February 1965. For biology of this species in Hawaii refer to Ota and Nishida (1966).

Parasites and predators: The following parasites of this species were released on Oahu, June 1961: *Chrysocharis majoriani* Girault, *Achrysocharis* sp., *Opius* sp. nr. *osciridis* Ashmead, and *Opius* sp. (ref. Davis and Krauss, 1962b:129). Ota and Nishida (1966:910) reported salticid spiders, the big-headed ant (*Pheidole megacephala* [F.]), and an anthocorid bug (*Orius insidiosus* [White]) preying upon adults, larvae, and eggs of this miner.

This large, all black bodied species is readily differentiated by having the halteres white with a prominent black spot on anteroapical portion. Also by having a moderately strong pair of prescutellar bristles in line with the posterior dorsocentrals; the front with three to four pairs of inferior fronto-orbital bristles; two pairs of erect, posterior setae on middle tibia; last section

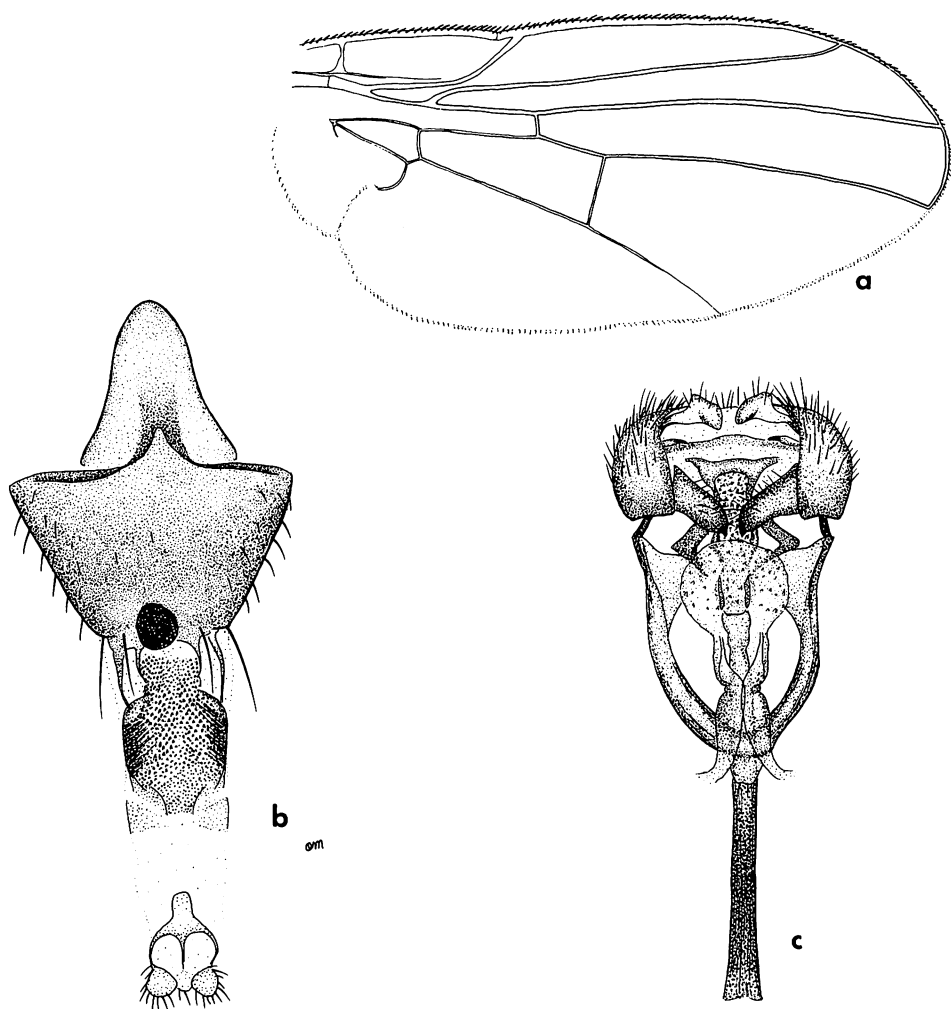


Figure 85—*Amauromyza maculosa* (Malloch): a, wing; b, posterior portion of female abdomen; c, male genitalia, ventral.

of $M_3 + 4$ about equal in length to penultimate section (fig. 85a); and genitalia as in figure 85c. Female terminalia as in figure 85b.

Length: body and wings, 3.0–3.3 mm.

Genus **CALYCOMYZA** Hendel

Dizygomyza, subg. *Calycomyza* Hendel, 1931, in Lindner, Die Flieg. Palaeark. Reg. 6:65. Type-species, *Agromyza artemisiae* Kaltenbach, by original designation.

References: Frick, 1952:394; Nowakowski, 1962:183.

Rather small *Liriomyza*-like species except that the scutellum is black and the pleura and legs brown to black; also, the genitalia are distinctly different as in figures 86c,d. The knobs of the halteres are white or yellowish. The prescutellar acrostichals are not enlarged, bristle-like. Only two pairs of inferior fronto-orbital bristles present. The last section of vein $M_3 + 4$ is about four times longer than penultimate section (fig. 86b). Spencer (1969:145) says all species of this genus have a distinctive patch of bristles on ventral hind corner of the epandrium (fig. 86e). Our species has previously been placed as a subgenus of *Phytobia*.

Only one species apparently occurs in Hawaii. Two have been recorded in our literature, but *jucunda* (van der Wulp), as identified by Frick, is evidently an error.

***Calycomyza humeralis* (Roser) (figs. 86a-e)**

Agromyza humeralis von Roser, 1840, Corresp. K. Württemb. Landw. Ver., Stuttgart 37(1):63. Type-locality: Europe.

References: Frick, 1952:394; Spencer, 1969:149.

Oahu, Midway, and Kure Island.

First recorded in Hawaii by Wirth (1947:21) under the name "*Calycomyza artemisiae* (Kaltenbach)." It was also recorded by Mitchell (1951) as *Agromyza* sp. (*jucunda* Wulp, of authors) and was misidentified as *Dizygomyza* (*Calycomyza*) *jucunda* (Wulp) by Frick (Hardy, 1952:476).

Immigrant. Widespread over much of the world: Europe, Africa, North America, Canada, Japan.

Hosts: The larvae form small yellowish blotch mines in *Aster* spp., *Erigeron* spp., *Solidago* spp. and other Compositae.

Parasites: *Hemiptarsenus semialbiclavus* Girault, *Derostenus fullawayi* Crawford, *Diglyphus begini* (Ashmead), *Cothonaspis pacifica* Yoshimoto, and *Eucoilidea* sp.?

This species is differentiated by the dark colored, brown to black face; the all white squamae and halteres; the angulate dorsal margin of third antennal segment (fig. 86a); and by the characteristics of the male genitalia (figs. 86c-e). Spencer (1969:149) allied this to *solidaginis* (Kaltenbach), but distinguished it by the black face, the more distinctly swollen mesophallus; presence of an obvious gap between the mesophallus and distiphallus (fig. 86d), "and the two sections of the distiphallus are paler, shorter, and slightly dilated."

Rather small subshining brown to black except for the yellowish front and genae, white squamae, halteres, lateral borders of mesonotum, including hind margins of humeri, area above humerus and notopleural area. Sides of vertex and upper eye orbits dark brown, two pairs each of inferior and superior fronto-orbitals. Antennae brown to black, third segment shaped as in figure 86a. Only three pairs of dorsocentral bristles, the anterior pair small and all postsutural in position. Four rows of acrostichal setae, extending posteriorly to about middle of distance between hind two pairs of dorsocentrals.

Length: body and wings, 1.5-1.75 mm.

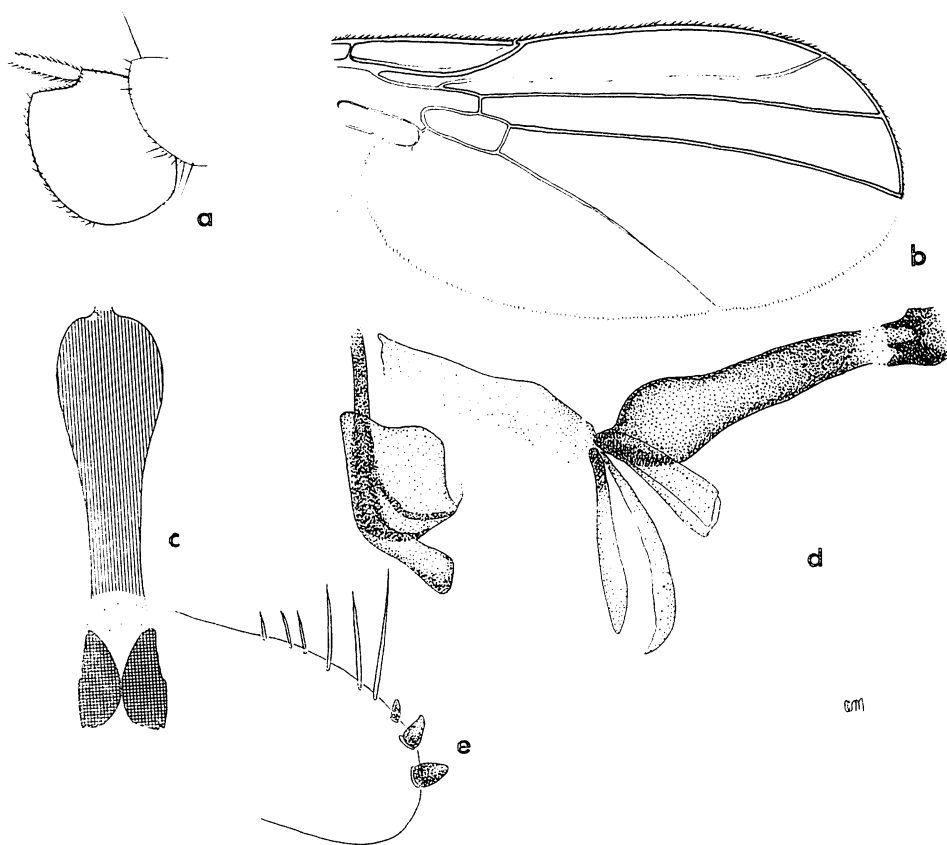


Figure 86—*Calycomyza humeralis* (Roser): a, antenna; b, wing; c, aedeagus, ventral; d, aedeagus, lateral; e, hind corner of male epandrium.

Genus **LIRIOMYZA** Mik

Liriomyza Mik, 1894, Wien. ent. Ztg. 13:289. Type-species, *uropharina* Mik, by monotypy.

Characterized by having bright yellow markings on head and thorax; the scutellum, humeri, halteres, pleura, head (except eyes), and the legs are predominantly or entirely yellow. The setulae along eye margins (orbital setulae) are reclinate. The costa extends to apex of vein $M_1 + 2$ and ends at or near apex of wing. The parafrontalia (genovertical plates of Frick, 1959:397, and others) are narrow, usually about one-fifth the width of front; the epandrium of the male has a spine on each inner caudoventral anle; and, according to Sasakawa (1961:389), "most of the known larvae have normally 3 bulbs on each posterior spiracle." In the Hawaiian literature previous to 1952, the *Liriomyza* were recorded as *pusilla* (Meigen); this species does not occur in Hawaii.

These are small flies and are the most abundant, and, in most cases, the most injurious species mining the leaves of vegetable crops and ornamentals. The Hawaiian species form serpentine-type mines.

Four species are known from Hawaii; all are introduced although a number of them have been described as endemic.

Sasakawa (1964a) revised the Hawaiian *Liriomyza*, but three of the six species he treated are synonymous. His key is of little value, and some of the descriptive information is confused.

KEY TO SPECIES OF LIRIOMYZA

1. Scutellum bright yellow, except for a brown basolateral spot on each side. Legs and mesopleura predominantly yellow. Four rows of acrostichal setae present. 2
 - Scutellum broadly black on sides, and mesopleura mostly black, or scutellum yellow-brown to black, concolorous with mesonotum; femora marked with brown to black. Six rows of acrostichals present. 3
2. In hardened specimens orbits and sides of vertex yellow. Surstylus of male lacking a secondary spine (fig. 87c). Distiphallus of male bifid apically (fig. 87d). The predominant serpentine leafminer in vegetable crops, except Cruciferae. *sativae* Blanchard.
 - In hardened specimens, sides of vertex and upper orbits tinged brownish yellow to brown. Surstylus with a prominent submedian secondary spine (fig. 87a); distiphallus blunt at apex (fig. 87b). Leaf miners in Cruciferae, Capparidaceae, and Tropaeolaceae. *brassicae* (Riley).
3. Surstylus of male with one long spine; aedeagus as in figure 89b. *huidobrensis* (Blanchard).
 - Surstylus of male with two short spines; aedeagus as in figure 88b. *cocculi* Frick.

Liriomyza brassicae (Riley) (figs. 87a-b)

Oscinis brassicae Riley, 1885, Ann. Rpt. U.S. Dep. Agric. 1884:322. Type-locality: Montana, U.S.A.

Phytomyza mitis Curran, 1931, Can. Ent. 53:97. Type-locality: Aweme, Manitoba, Canada.

Liriomyza hawaiiensis Frick, 1952, Proc. Haw. Ent. Soc. 14:513. Type-locality: Honolulu, Oahu.

For other synonyms refer to Spencer (1973:153).

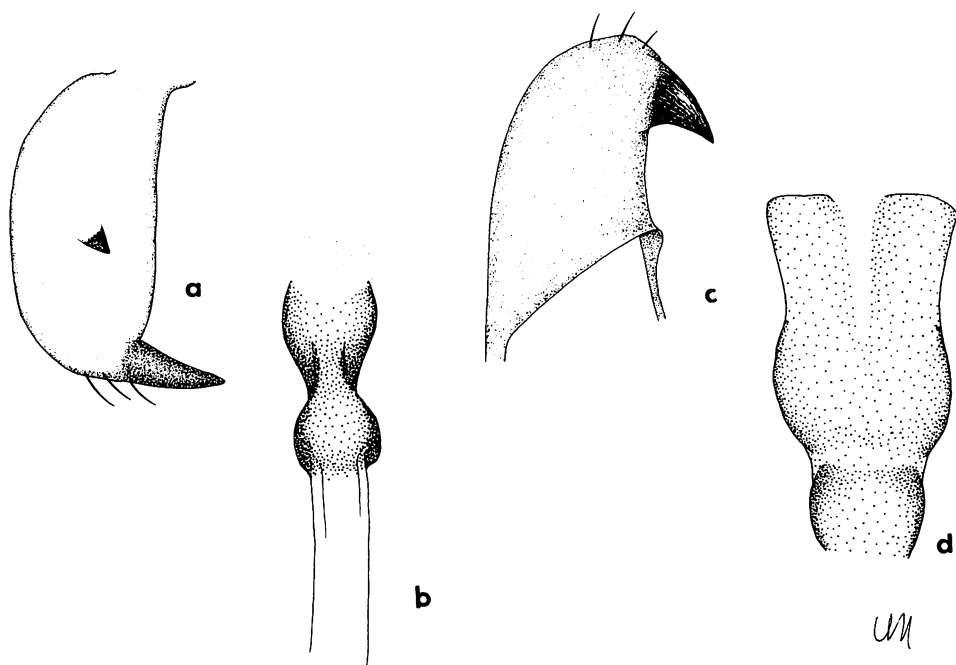


Figure 87—*Liriomyza brassicae* (Riley): a, surstylus of male; b, distiphallus. *L. sativae* Blanchard: c, surstylus; d, distiphallus.

Widespread over all the main Hawaiian Islands. First recorded from Oahu by Frick (1952:516).

Immigrant. Cosmopolitan.

Hosts: The larvae form linear mines on many species and genera of Cruciferae, Capparidaceae (*Cleome* and *Gynandropsis*) and Tropaeolaceae (*Nasturtium*). A serious pest on cabbage, broccoli, cauliflower, and other cruciferous crops. The recording of this species from tomato in the original description of *hawaiiensis* was obviously an error and it probably does not infest Solanaceae.

Parasites: The following have been reared in Hawaii: *Cothonaspis pacifica* Yoshimoto, *Chrysocharis parksi* Crawford, and *Halticoptera patellana* (Dalman).

Stegmaier (1967:260) reared the following parasites from *brassicae* in Florida: *Chrysocharis* spp., *Diaulinopsis callichroma* Crawford, and *Pnigalio* sp.

Sasakawa (1964a:431) resurrected *hawaiiensis* after it had been synonymized by Spencer (1963b:356). We have checked the male genitalia on the entire series of specimens which have been determined as *brassicae* and *hawaiiensis* (including paratype series) and agree with Spencer that these are synonyms. Sasakawa used as his key character, for separating *brassicae*, "parafrontalia brown laterally." This character is entirely dependent upon the degree of teneralty and over 90% of the specimens in the collections on hand have been

reared and the adults killed before hardening. The color characters are not reliable and identification has to be based on male genitalia.

L. hawaiiensis supposedly differed from *brassicae* by having the orbits entirely yellow, rather than brown to black. As has been discussed by Spencer (1963a:158, 1963b:356, 1969:171) this is a variable character and although the orbits are typically darkened in most populations, it is not a constant character, and pale forms are frequently found, especially in Micronesia and Hawaii. As mentioned above, we are convinced that this is due to tenacity.

Frick (1953:212) differentiated *brassicae* (along with *hawaiiensis*) by having inner postalar bristles distinctly more than half as long as outer postalar, while in other *Liriomyza* it is half or less than half as long. This character is apparently variable and seems of no value in separating this species.

In Hawaii this species has been confused with *sativae* Blanchard as "*minutiseta*" Frick, and because of the difficulties in separating these, the species which attack various crops in Hawaii have had to be referred to as *Liriomyza* spp.?

Fully hardened specimens can be differentiated by having sides of vertex and the upper eye orbits at least slightly tinged with brown; in some specimens this is dark brown, and by having the lower margin and anterior edge of mesopleuron broadly brown and a small brown spot on upper anterior corner of mesonotum. The diagnostic features for separating the species are in the male genitalia. The distiphallus is broad, blunt, and rounded at apex, with the extreme apex semi-membranous and pale colored (fig. 87b). Also, the surstylus has a prominent, secondary, submedian spine (fig. 87a).

***Liriomyza cocculi* (Frick) (figs. 88a-c)**

Phytobia (Praspedomyza) cocculi Frick, 1953, Proc. Haw. Ent. Soc. 15:210.

Type-locality: Pupukea, Oahu.

On all the main islands.

Immigrant?

Hosts: In Hawaii this has been reared only from native plants in the mountains, including the following plant genera: *Cocculus* (Menispermaceae), *Myoporum* (Myoporaceae), *Peperomyia* (Piperaceae), *Pteralyxia* (Apocynaceae), *Wikstroemia* (Thymelacaceae), and *Chenopodium* (Chenopodiaceae). Dr. O. H. Swezey, in his *Forest Entomology in Hawaii* (1954), recorded agromyzid leaf miners in the following plants: *Alyxia* sp. (Apocynaceae), p. 27; *Marattia douglasii* (Presl.) Baker (Marattiaceae), p. 90; *Clermontia persicifolia* Gaudichaud, p. 117; *C. arborescens* (Mann) Hillebrand, p. 117; and *Lobelia* sp., p. 120 (Lobeliaceae); also from *Pteralyxia* sp., p. 176. He was not successful in rearing any adults and said most specimens were killed by parasites. Mines have also been seen on leaves of *Acacia koa* Gray (Leguminosae) by Dr. J. W. Beardsley at Kilauea, Hawaii, but no adults have been reared. It is probable that all of these records pertain to *cocculi*. This could become a dangerous pest if it gets into the vegetable growing areas of Kamuela and Kilauea, Hawaii.

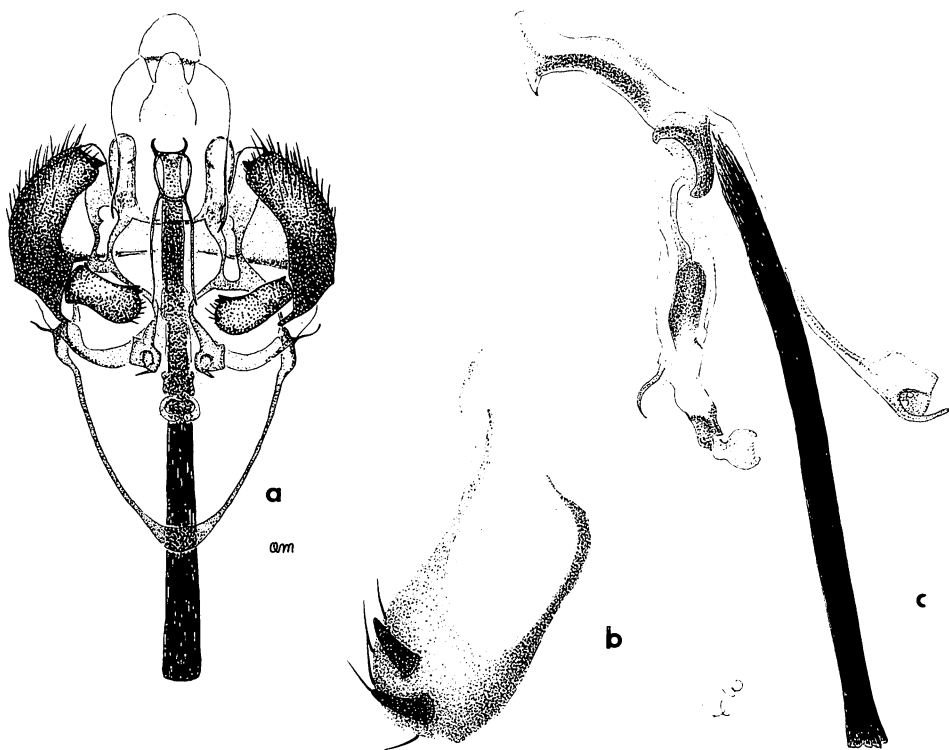


Figure 88—*Liriomyza cocculi* (Frick): a, genitalia, ventral; b, sursstylus; c, aedeagus.

Eulophid and cynipid (Eucoilinae) wasps have been reared from the miners and the parasitism rate in the miners on native plants seems unusually high.

This species, at least in Hawaii, shows a rather wide range of color and size variations. The specimens described by Frick and as represented in his type series (all are teneral), have the scutellum yellow-brown, rather evenly colored and nearly concolorous with the mesonotum. It was on this basis that Frick described *cocculi* as a *Phytobia* (*Praspedomyza*) Hendel. As pointed out by Sasakawa (1964a:430) and confirmed by Spencer (pers. comm.) on the basis of the male genitalia, this belongs in *Liriomyza*. In some fully-hardened specimens, the scutellum is dark brown to blackish, concolorous with the mesonotum and the pleura mostly dark colored. Sasakawa (*loc. cit.*) has noted that two distinct color forms seem to occur in Hawaii. The typical specimens over the Islands are characterized by having the sides of the scutellum broadly black, and median portion yellow; the black extending to or nearly to bases of apical bristles; the mesopleuron dark brown to blackish except for dorsal, and extremely narrow posterior margins; six irregular rows of acrostichal setae are present; the femora marked with brown to black on dorsal surfaces and the tibiae and tarsi are black. Also, the specimens are consistently larger than

those in Frick's series, body and wings ranging from 2.2–3.4 mm., rather than 1.3–1.8 mm. for the body and 1.6–2.0 mm. for wings.

This fits very close to *huidobrensis* (Blanchard) and is differentiated only by male genital characters. The surstylus has two stout spines on or near lower margin (fig. 88b), rather than one long curved spine (fig. 89b). Sasakawa (1964a:430) redescribed and figured this species. He gave the length: "body 0.96–1.59 mm. in male, 1.10–1.65 mm. in female; wing 1.38–1.65 mm. in male, 1.51–1.65 mm. in female." The male genitalia are as in figures 88a–c.

Because of the rather wide range of variation in this species over the Islands, it would appear that this may be in the process of speciating. The various populations and host associations need to be studied in detail.

***Liriomyza huidobrensis* (Blanchard) (figs. 89a–c)**

Agromyza huidobrensis Blanchard, 1926, Revta Soc. Ent. Argentina 1:10.

Type-locality: Argentina.

Liriomyza langei Frick, 1951, Pan-Pacif. Ent. 27:81. Type-locality: Sunnyvale, California.

For other synonymy refer to Spencer (1973:215).

Oahu, Kauai. The earliest collections were made on Oahu, Mt. Kaala, 1952, and Waimano Home, 1958 (D. E. Hardy).

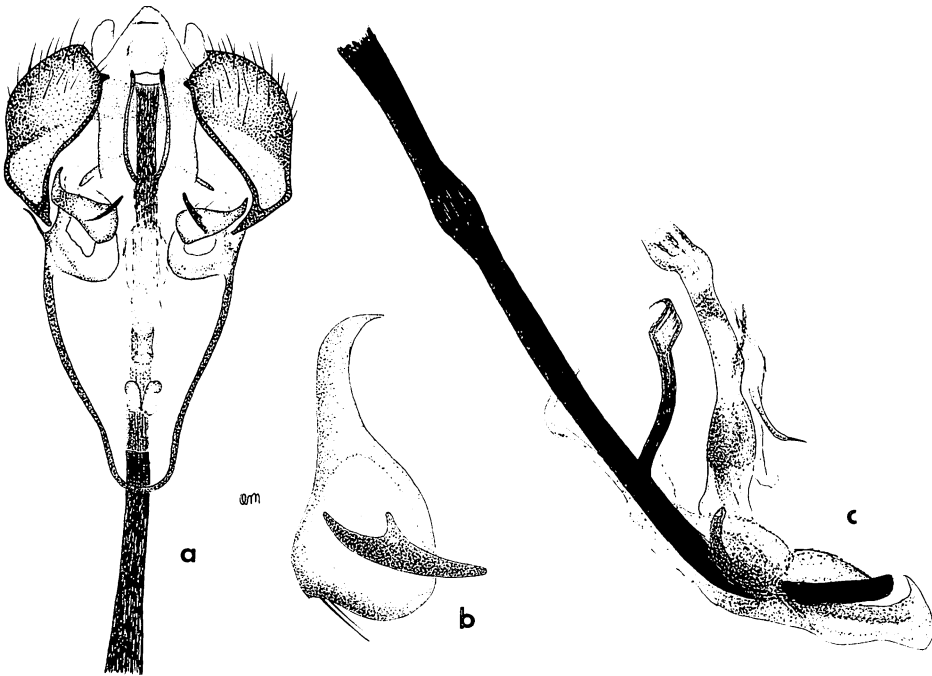


Figure 89—*Liriomyza huidobrensis* (Blanchard): a, male genitalia, ventral; b, surstylus; c, aedeagus.

Immigrant. Western North America and Neotropical Region.

Hosts: A polyphagous feeder, mining leaves of many plants, including garden peas (*Pisum sativum* L.), aster, celery, and spinach in California (Frick, *loc. cit.*:83), and "a wide range of hosts in South America" (Spencer, pers. comm.). The species has not been reared in Hawaii; potentially it could be a pest of many economic plants.

Resembles *cocculi* Frick because of the predominantly dark-colored pleura and legs; having five to six rows of acrostichal setae; and by having the sides of scutellum broadly black and the median portion yellow. Our concept of the species is based upon specimens from Waimano Homes, Oahu, determined as typical *langei* by Spencer. It is of average size for *Liriomyza* (body and wings, 1.75 mm.), with wings hyaline and differentiated from *cocculi* by having the surstylus with one strong curved apical spine (fig. 89b). Ventral aspects of genitalia as in figure 89a and aedeagus as in figure 89c. *L. cocculi* seems to be restricted to the highlands (mostly 4000–6500 ft.) of the main Islands. Specimens are consistently larger, body and wings ranging from 2.2–3.4 mm.; the wings are slightly dusky and the surstylus has two short teeth (fig. 88b).

It should be noted that the original description of *langei* is based largely upon color. This is variable and some of the characters Frick uses are not reliable. He allies *langei* to *obona* (Meigen), from Europe, and differentiates the latter by having the posterior margin of the anepisternum narrowly yellow (*loc. cit.*, fig. 2). Many of the Hawaiian specimens are like this while others fit typical *langei* (*loc. cit.*, fig. 1).

***Liriomyza sativae* Blanchard (figs. 87c–d)**

Liriomyza sativae Blanchard, 1938, An. Soc. Cient. Argentina 126:354.

Type-locality: Argentina.

Agromyza (*Liriomyza*) *subpusilla* Frost, 1943, J. N.Y. Ent. Soc. 51:255 (preocc. Malloch, 1914). Type-locality: Manhattan, Kansas.

Liriomyza pullata Frick, 1952, Proc. Haw. Ent. Soc. 14:509. Type-locality: Kanoa, Molokai.

Liriomyza canomarginis Frick, 1952, Proc. Haw. Ent. Soc. 14:511. Type-locality: Kaimuki, Oahu.

Liriomyza minutiseta Frick, 1952, Proc. Haw. Ent. Soc. 14:512. Type-locality: Honolulu, Oahu.

Liriomyza propepusilla Frost, 1954, Ent. News 65:73 (new name for *subpusilla* Frost, not Malloch).

Liriomyza munda Frick, 1957, Pan-Pacific Ent. 33:61. Type-locality: San Joaquin Co., California.

Liriomyza guytoni Freeman, 1958, Ann. Ent. Soc. Amer. 51:344. Type-locality: Auburn, Alabama.

For synonyms refer to Spencer (1973:219).

The most common serpentine leaf miner over all of the main Hawaiian Islands.

Immigrant. Widespread over North, South, and Central America; Guam and Tahiti.

Hosts: One of the most polyphagous of the *Liriomyza*. In Hawaii it is a serious pest of tomatoes, beans, eggplants, cauliflower, and squash and has been reared from the following plant families: Solanaceae, Cucurbitaceae, Leguminosae, Umbelliferae, Liliaceae (onions), Passifloraceae, Sapindaceae, Compositae, Boraginaceae, Mimosaceae, Malvaceae, Amaranthaceae, Euphorbiaceae, also rarely Cruciferae (specimens have occasionally been reared from cauliflower and won bok (*Brassica pekinensis* (Lour.) Rupr.). In other areas it has been reared from numerous plant species belonging in at least eleven families (ref. Steyskal, 1964:388; Spencer, 1973:221). Spencer (in litt.) says this is the most important agromyzid pest in America.

Parasites: The following have been reared: *Opius dissitus* Muesebeck; *Halticoptera patellana* (Dalman); *Diglyphus begini* (Ashmead); *Hemiptarsenus semialbiclavus* (Girault); *Derostenus fullawayi* Crawford; *Chrysocharis parksi* Crawford; and *Closterocerus* sp., *utahensis* (Girault).

For biology and control refer to Tamashiro and Habeck (1963).

As noted by the synonymy listed above, the concepts of this species have been very confused in the literature. This has probably arisen from the fact that workers on these flies have often assumed them to be host specific, or at least restricted to related groups of plants, and utilization of such widely differing hosts was thought to imply different species.

This species is similar to *brassicae* (Riley) in most respects and teneral specimens cannot be differentiated with certainty except by characteristics of the male genitalia. In the literature this has been differentiated largely on color differences and on the supposed differences in the size of the inner postalar bristles. Frick described these bristles as rather small: one-third as long as outer postalars in *minutisetæ*; about two-fifths as long in *canomarginis*, and one-half as long in *pullata* compared to inner postalars "strong, slightly more than half as long as outer" in *hawaiiensis*, (= *brassicae*). We see no value in using this character; the size of the inner postalar is obviously variable. Also, we find that almost without exception the specimens used by Frick for his descriptions were teneral.

L. sativae has the sides of the vertex, between the vertical bristles yellow, so that the inner verticals are located on the yellow background; also, the mesopleuron is almost all yellow, with a small brown to black mark on anteroventral portion, sometimes continuing vertically as a narrow mark part way across sclerite. In fully hardened specimens of *brassicae*, the sides of the vertex, in Hawaiian specimens, is brownish yellow, including the area at base of inner vertical bristle and continuing along the orbits as at least a faint tinge of brown. Also the mesopleura is supposed to have a larger brown mark over front portion. These color characters are of questionable diagnostic importance, especially in dealing with reared specimens which have been killed before fully hardening. The male genitalia are the only sure characters which can be used for separating these. The distiphallus is bifid apically (fig. 87d) and the surstylus lacks a secondary spine (fig. 87c). In *brassicae* the dististylus is blunt apically (fig. 87b) and a prominent secondary spine is present on the surstylus (fig. 87a).

For the most part, *L. sativae* and *brassicae* can be separated by host selection. The latter has been found only in cabbage and related plants, in *Cleome*, *Gynandropsis*, and in *Nasturtium* (*Tropaeolum*) while *sativae* is found in a wide range of plants such as tomatoes, beans, eggplants, squash, and onions, but only rarely in Cruciferae (cauliflower and won bok).

Genus **PHYTOLIRIOMYZA** Hendel

Liriomyza, subg. *Phytoliriomyza* Hendel, in Lindner, 1931, Die Flieg. palaeark.

Reg. 6:203. Type-species, *Agromyza perpusilla* Meigen, by monotypy.

Xyraemyia Frick, 1952, Univ. Calif. Publ. Ent. 8(8):412. Type-species, *conjunctimontis* Frick, by original designation.

Differentiated from other Phytomyzinae by having the orbital setulae conspicuously proclinate; the costa extending to vein $M_1 + 2$; and only one pair of inferior fronto-orbital bristles. Somewhat resembling *Liriomyza* but differing by being predominantly dark colored; gray pollinose body; eyes oblique in position, rather than vertical; arista elongate two-thirds to nearly two times longer than the inner vertical bristles, rather than being short, scarcely longer than the inner verticals. Also, the sparse acrostichals, proclinate orbital setulae, and distinctive genitalia (fig. 90b) readily separate these.

In the Hawaiian species, the median portion of the front is brown, the face and genae are yellow-white. The thorax is densely gray pollinose; the mesonotum has four pairs of well-developed dorsocentral bristles but only a few acrostichal setae arranged in two rows on anterior portion.

Only one known Hawaiian species. The genus has been reviewed by Spencer (1964c).

Phytoliriomyza montana Frick (figs. 90a-d)

Phytoliriomyza montana Frick, 1953, Proc. Haw. Ent. Soc. 15:213. Type-locality: Koolau Gap, Haleakala Crater, 7000 ft., Maui.

Phytoliriomyza perpusilla Frick, 1952, Proc. Haw. Ent. Soc. 14:516 (misidentification).

Endemic? Present on all of the main islands mostly at elevations of 3000–6000 ft., but some near sea level and some as high as 10,000 ft.

First recorded by Frick (1952b:516) as “*Phytoliriomyza perpusilla* (Meigen);” collected on Oahu, July, 1946.

Hosts: Host plants unknown. Frick said it is probable that the larvae are stem miners in one or more native plants. Specimens are collected predominantly in areas where the vegetation is native. The only plant association to date are specimens collected on *Dodonaea*, *Cyathodes*, and *Coprosma*, Haleakala, Maui; on *Myoporum*, *Osteomeles*, and *Sophora*, Ahumoa Crater, Hawaii.

According to Frick (original description) this species is differentiated from other known species by having the eyes pilose and “by its dark coloration, particularly of the anepisternum and legs.” Frick keys this near *halterata* (Becker),

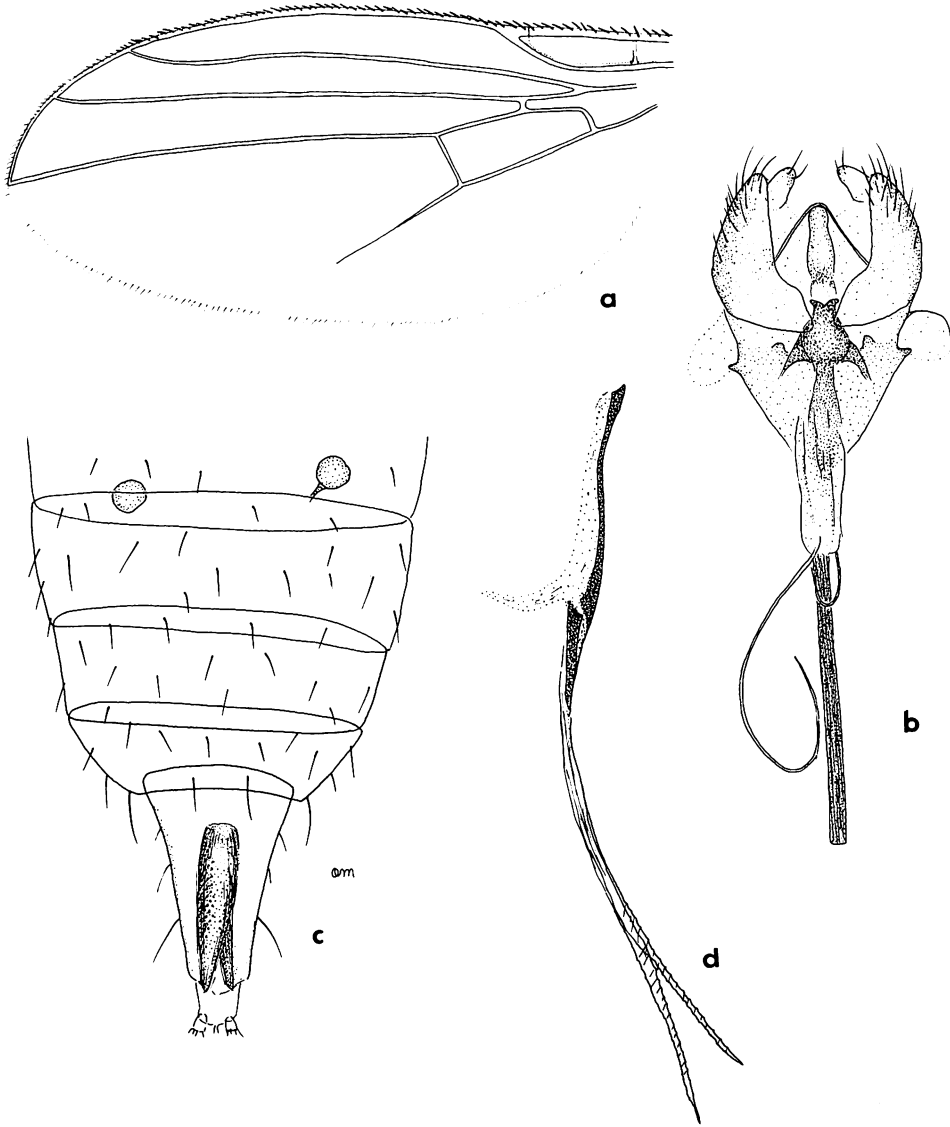


Figure 90—*Phytoliriomyza montana* Frick: a, wing; b, male genitalia, ventral; c, female abdomen; d, aedeagus.

(= *arctica* [Lundbeck], ref. Spencer, 1964c:659) by having the mesopleura mostly dark colored, grayish-black. He separates it from "*halterata*" by having mesopleura dark colored except for narrow yellow band along top edge rather than ventrally about one-half darkened; also, the m crossvein of *montana* approximately perpendicular to vein $M_1 + 2$ rather than situated at an acute angle to penultimate section of $M_1 + 2$.

In Spencer's keys (1964c:857, 1969:201) this runs to *arctica* (Lundbeck) because of the comparatively short last section of vein $M_1 + 2$ (about one and one-half longer than penultimate section (fig. 90a) rather than at least two times longer). It apparently differs from typical *arctica* by being predominantly dark colored; this cannot, however, be considered diagnostic. Spencer (1969:202) said that *arctica* is "highly variable in color; frons, pleura, and legs vary from almost black in northern specimens from Greenland, Labrador, and Alaska to largely yellow." Spencer also says that the eye of *arctica* are "normally distinctly pilose but the hairs may be sparse and scattered or almost absent, or conspicuously long and thick." Spencer (1963b) keys *arctica* by having the third antennal segment larger, more elongate, yellowish, though normally darker above, rather than being small and rounded; and distiphallus with "a pair of long translucent coiled tubules extending far beyond end of ninth sternite. Spermal sac [ejaculatory apodeme] small.

The diagnostic characters for separating *montana* and *arctica* are: third antennal segment small, rounded, entirely brown to black, distiphallus not extending into long coiled tubules, and with tiny spicules at apex (fig. 90d), compare with figure 364 (Spencer, 1969:204).

The generic characters cited above will differentiate this from other known Hawaiian agromyzids. The wings are as in figure 90a, the male genitalia as in figures 90b, d, and the female abdomen and spermathecae as in figure 90c.

Wing length: 1.6–2.0 mm.

Genus **PHYTOMYZA** Fallén

Phytomyza Fallén, 1810, Spec. Ent. nov. Dipt.:21, 26. Type-species, *flaveola* Fallén, by monotypy.

Readily separated from other Phytomyzinae which have the orbital setulae proclinate and the acrostichal setae sparse, arranged in two rows or nearly lacking on anterior portion of mesonotum, by the costa extending only to end of vein $R_4 + 5$ and the m crossvein lacking in the Hawaiian species.

According to Spencer (1969:218), this is the largest genus of Agromyzidae with 400 described species for the world. Only one is known from Hawaii.

Phytomyza plantaginis Robineau-Desvoidy (fig. 91a)

Phytomyza plantaginis Robineau-Desvoidy, 1851, Rev. Mag. Zool. 3:404.

Type-locality: France.

Phytomyza genualis Loew, 1869, Berl. Ent. Zt. 13:52. Type-locality: District of Columbia, U.S.A.

Kauai, Molokai, Hawaii, Maui; probably on all the Hawaiian Islands. First recorded from Kauai, April 1963 by Sasakawa (1964b:427). A female specimen is on hand from Molokai.

Immigrant. Throughout North America, Canada, Europe, Formosa, Japan, and Australia.

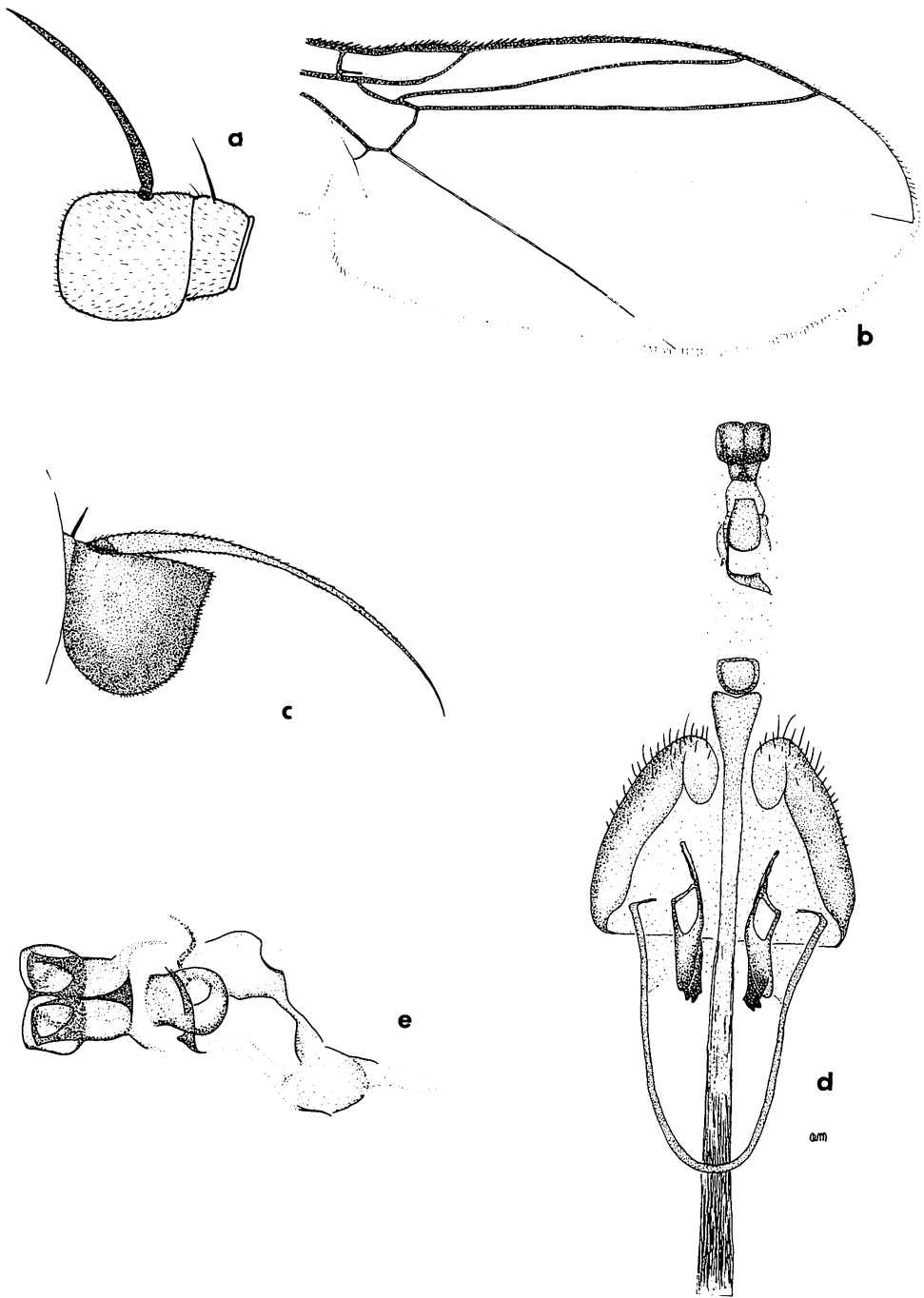


Figure 91—*Phytomyza plantaginis* Robineau-Desvoidy: a, antenna. *Pseudonapomyza spicata* (Malloch): b, wing; c, antenna; d, male genitalia, ventral; e, distiphallus.

Host: Larvae form linear mines in *Plantago* spp. Sasakawa reared it from *Plantago lanceolata* L.

This species is characterized by the following combination of characters: almost complete lack of acrostichal setae; crossvein m lacking; third costal cell, between R_1 and $R_2 + 3$, short, one-half to two-thirds longer than second; front, face, and genae pale yellow; thorax dark colored, except for yellow upper margin of mesopleuron and white knobs of haltere gray pollinose; legs brown to black except for yellow front coxae and yellow apices of femora; third antennal segment quadrate (fig. 91a), dark brown to black, second segment yellow. Two pairs of equal superior fronto-orbital bristles and one pair of strong incurved, plus one pair of weak seta-like, inferior fronto-orbitals. The proclinate orbital setulae are well developed. Four strong pairs of dorsocentral bristles, one pair presutural.

Wing length: 2.0–2.2 mm.

Genus **PSEUDONAPOMYZA** Hendel

Pseudonapomyza Hendel, 1920, Arch. Naturgesch. (A) 84:115. Type-species, *Phytomyza atra* Meigen, by original designation.

Differentiated from other Phytomyzinae in Hawaii which have the orbital setulae reclinate and which have abundant acrostichal setulae by having the costa short, ending at apex of vein $R_4 + 5$; the third antennal segment pointed at upper apex (fig. 91c); the third costal section, between tips of R_1 and $R_2 + 3$, comparatively short, about one-half longer than second costal section; and m crossvein apparently lacking or appearing to be the basal section of $M_3 + 4$ and situated basad of r-m (fig. 91b).

The species known from the Oriental and Pacific regions are treated by Spencer (1966b:511–514).

One known species in Hawaii.

Pseudonapomyza spicata (Malloch) (Figs. 91b–e)

Phytomyza spicata Malloch, 1914, Ann. nat.-hist. Mus. natn. hung. 12:334.

Type-locality: Formosa.

Recorded from all the main Hawaiian Islands except Lanai, also seen from Nihoa and Kure islands. First reported in Hawaii by Van Zwaluwenburg in November, 1946 (1947). This is the species reported by Wirth (1947) as *Napomyza* sp.? “taken on window near beach, Kailua, Oahu, June 1, 1946.”

Immigrant. Widespread over Pacific and Oriental region: Formosa, Micronesia, Fiji, Samoa, Bismarck Islands, Australia, India, Philippines, and Thailand.

Host: The larvae mine the leaves of many species of grasses (Gramineae), including corn and sugar cane. They produce narrow, longitudinal, parallel mines in upper surface of leaf. Mines up to 2.0 mm. wide at ends. Frass scattered in conspicuous stripes at sides of channel. Pupation occurs outside of mines.

Parasites: The following have been recorded from this fly in Hawaii: *Hemiptarsenus semialbiclavus* (Girault), *Achrysocharis fullawayi* (Crawford), *Clostocerus* sp. and *Merisus* sp.

Differentiated from most other *Pseudonapomyza* by having the mesonotum shining black and the third antennal segment pointed at upper apex (fig. 91c); and by the puparium having a conspicuous row of papillae over each segment. It is very close to *spinosa* Spencer and is differentiated by having the section of costa between tips of veins R_1 and $R_2 + 3$ distinctly longer than that section between $R_4 + 5$ and $M_1 + 2$ (fig. 91b) and the distiphallus small, pale, and divided into two sections (fig. 91e).

Small, mostly shining black species, knobs of halteres white. Head higher than long. Only one pair of superior fronto-orbital bristles and with three pairs of incurved inferior fronto-orbitals; the lower ones are small seta-like. Three pairs dorsocentral bristles, all postsutural and with four irregular rows of strong acrostichal setae. Genitalia as in figures 91d and 91e.

Wing length: 1.6–1.75 mm.

***Pseudonapomyza spinosa* Spencer (figs. 92a–b)**

Pseudonapomyza spinosa Spencer, 1973, Agromyzidae of Economic Importance, W. Junk Pub. Series Entomologica 9:275. Type-locality: Alexandria, Egypt.

Immigrant? Widespread over Africa, India, Australia, and the Pacific. It may possibly occur in the Hawaiian Islands.

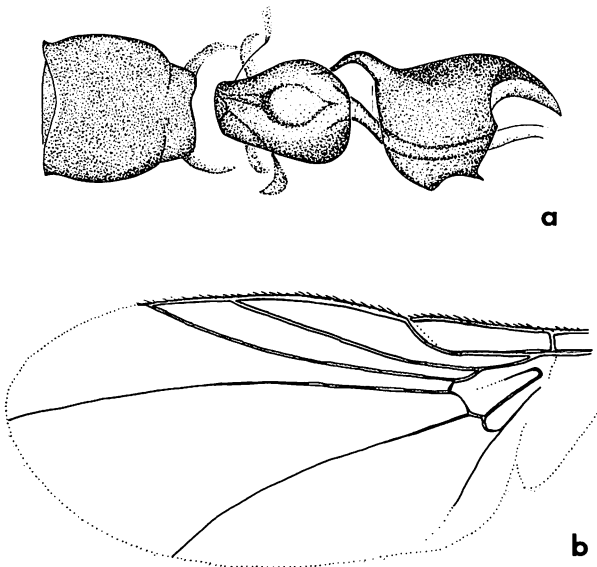


Figure 92—*Pseudonapomyza spinosa* Spencer: a, distiphallus; b, wing.

Hosts: According to Spencer (*loc. cit.*) it infests *Hordeum vulgare* L. [barley] (Egypt), *Triticum cereale* L. [wheat] (Nigeria), also *Eleusine indica* Gaertn, [winegrass] (Australia).

Fitting the description of *spicata* (Malloch), but differing by having the section of costa between apices of veins R_1 and $R_2 + 3$ about equal in length to that section between tips of $R_4 + 5$ and $M_1 + 2$ (fig. 92b) and the distiphallus large, conspicuously dark colored and not divided apically (fig. 92a).

Family AULACIGASTRIDAE

This family was first erected by Duda (1924:176) to contain the genus *Aulacigaster* Macquart. Hennig (1958:640) outlined the family characters and added the genus *Schizochroa* Hennig, and said that *Cyamops* Melander probably also belongs here. Hennig (1969:606, 1971:39) later gave more detailed treatment of the group, including relationships with other families, and added the genera *Cyamops*, *Planinasus* Cresson, and *Stenomicro* Coquillett.

Hennig (1969:606) cites the following characteristics for separating Aulacigastriidae.

1. Postvertical bristles absent.
2. Ocellar bristles reduced or absent.
3. Vibrissae present.
4. Costa broken at end of vein Sc.
5. Only two fronto-orbital bristles present, the front pair bent inward.
6. Mouth opening large.
7. Sc fused with R_1 for a certain distance before entering costa.
8. Only one postalar bristle present.

Some of these characters are also found in Anthomyzidae and in Periscelidae and are not restricted to Aulacigastriidae.

Hennig (1971:37) places Aulacigastriidae in the "Periscelidea" subgroup of families, along with Periscelidae, Asteiidae, and Tetratomyzidae, by having the face sclerotized throughout, convex in profile and not membranous in the middle, as well as by other details.

Only the genus *Stenomicro* is present in Hawaii and it has been just recently (1971) removed from Anthomyzidae. It is differentiated from the anthomyzid genera represented in Hawaii (*Amygdalops* Lamb and *Mumetopia* Melander) by lacking ocellar bristles; postocellars (postvertical) lacking or represented only by fine hairs; anteromedian portion of face above clypeus (praepron, of Hennig) well sclerotized, prominent, and flattened, bearing a strong pair of median bristles (vibrissae) (fig. 93b); and the palpi rudimentary, difficult to discern, papilliform. In Anthomyzidae the anteromedian portion of the face is weakly sclerotized, poorly developed, and the upper pair of vibrissae are on the genae, below the eye margin; also, the palpi are well developed, prominent. Most of the aulacigastriids have three spermathecae. However, *Stenomicro* (also *Planinasus*) have only two, as in the Anthomyzidae.

Genus **STENOMICRA** Coquillett

Stenomicra Coquillett, 1900, Proc. U.S. natn. Mus. 22:262. Type-species, *angustata* Coquillett, by original designation.

Podocera Czerny, 1929, Konowia 8:93. Type-species, *ramifera* Czerny, by monotypy.

Diadelops Collin, 1944, Ent. mon. Mag. 80:265. Type-species, *delicata* Collin, by monotypy.

Stenomicra Coquillett, Sturtevant, 1954, Proc. U.S. natn. Mus. 103:560. Type-species, *angustata* Coquillett, by original designation.

References: Malloch, 1927 (rev. key); Hennig, 1958:633; Sabrosky, 1965b: 211 (Generic characters, relationship, redescrptions, synonymy).

Small, slender bodied flies, usually 1.5–1.75 mm. long. Resembling Anthomyzidae in most respects but differentiated by the characters given under the family discussion above. Sabrosky (1965b) gives a thorough discussion of the morphological characteristics. The head is broader than the thorax, strongly concave posteriorly, and with a rather sharp rim along upper vertex. As seen in lateral view the epistomal margin is protruded and, in some species, snout-like. Eyes diagonal, longer than wide and sparsely pubescent. The inner vertical bristles are proclinate and the postocellars, when discernible, are minute, weak, and hair-like. One pair strong and one weak fronto-orbitals. According to Sabrosky “true vibrissae apparently absent, but uppermost pair of facial bristles developed as porrect and slightly dorsoclinate and divergent ‘pseudovibrissae,’ followed posteroventrally on each side by a row of peristomal hairs and bristles.” Second antennal segment larger than third, the latter decumbent, with long hairs along dorsal margin. Arista with long dorsal and ventral rays as in *Drosophila*. Wings long, rather narrow with alula absent or very narrow. Vein Sc incomplete, R_1 very short and $R_2 + 3$ usually very long. Cubital vein and cell ranging from distinct to absent.

For keys to the genus refer to Malloch (1927b:24), Sturtevant (1954:447), and Sabrosky (1965b:212).

Sabrosky (1965b:209) and others have treated this under Anthomyzidae and the genus has previously been referred to the Drosophilidae, Asteiidae, Geomyzidae, and Periscelididae, and now, according to Hennig’s classification (1971:39), it belongs in Aulacigastriidae.

Stenomicra orientalis Malloch (figs. 93a–c)

Stenomicra orientalis Malloch, 1927, Ann. Mag. nat. Hist. (9)20:25. Type-locality: Mt. View, Hawaii and Oahu.

Endemic? Hawaii.

Erroneously recorded as *S. angustata* Coquillett, by Williams (1933) (refer to Hardy, 1952a:472). First collected on Hawaii and Oahu in 1908 by O. H. Swezey.

Biology: The larvae apparently feed as scavengers in the leaf sheaths of

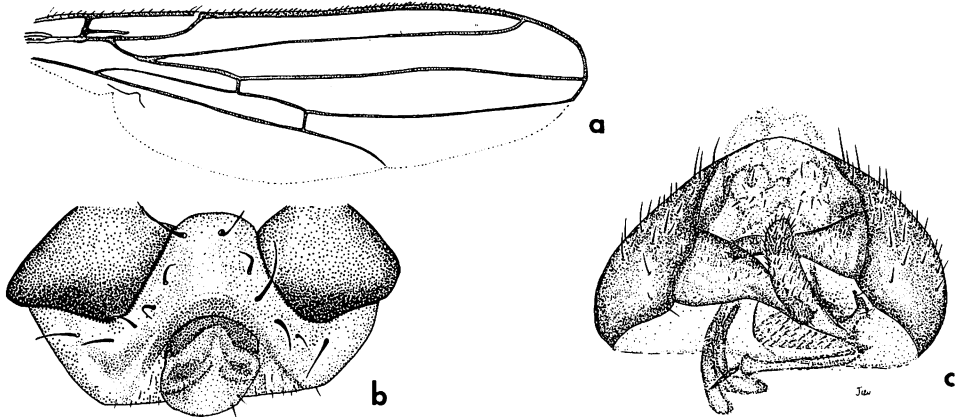


Figure 93—*Stenomicroa orientalis* Malloch: a, wing; b, facial view; c, male genitalia, ventral.

sugar cane, pineapple, *Pandanus*, Job's tears, and other monocotyledonous plants. Williams (1939:281-284, pl. 14, figs 1-4) discusses the biology and habits and illustrates the egg, larva, pupa, and adult.

Malloch allied this to *S. australis* Malloch, from Queensland, and separates the two on the basis of male genital characters. "The forceps [surstyli] shorter and stouter, and the longest of the internal processes [pregonites, or parameres] quite noticeably spatulate." Compare figures 4, 8, 5 and 9 (Malloch, *loc. cit.*).

Head shaped as in Malloch's figure of *australis* (*loc. cit.*, fig. 1) with eyes diagonal in position and anteroventral portion of head produced, rather snout-like. Head pale yellow, except for compound eyes and ocellar triangle. Mesonotum and scutellum brown, tinged with rufous. Abdomen with first and fifth terga pale yellow, two to four with broad brown crossbands and terminal portion brown. Wings hyaline, venation as in figure 93a, with third costal section (between tips of R_1 and $R_2 + 3$) about three times longer than fourth section. Vein $M_3 + 4$ evanescent, not reaching wing margin. Cubital cell incomplete, vein Cu weak. Distance from m crossvein to wing margin, along course of vein $M_3 + 4$, nearly two times greater than length of penultimate section of $M_1 + 2$. In Malloch's figure of the wing of *australis*, the ultimate section of $M_3 + 4$ is equal in length to the penultimate section of $M_1 + 2$. Male genitalia as in figure 93c. The surstyli are moderately thickened, rounded at apices.

Seventh sternum of female weakly sclerotized, as wide as long. Eighth sternum entire, not divided medianly. Two large round spermathecae.

Length: body and wings, 1.75-2.0 mm.

Family ANTHOMYZIDAE

Small, slender-bodied flies with long narrow wings, the alulu very narrow or absent. Resembling Opomyzidae, and previously included in this family by

many authors. The anthomyzids differ by having well developed vibrissae; no presutural dorsocentrals; postvertical bristles well developed and convergent; "male with sixth tergum well developed, and epiphallus present; and according to Vockeroth (1961:504, after Hennig, 1939b, 1958), the females differ by having only six pairs of abdominal spiracles, the tergum and sternum of the seventh abdominal segment not fused, and segment eight and succeeding structures slightly compressed. The female ovipositor is not retractile. Only two spermathecae are present.

In addition to the above, the third antennal segment is set at nearly a right angle to the second; arista plumose (in Hawaiian species); postvertical (postocellars) bristles well developed, convergent; at least one strong bristle present on vibrissal margin, and at least one pair of reclinate inferior fronto-orbitals present; face semimembranous down median portion, as discussed below and not convex; mesopleura and disc of scutellum bare; subcostal vein incomplete, or vestigial; costa broken only at end of Sc; vein R_1 short, ending near basal third of wing; cubital cell (anal of other authors) usually complete. Vein $R_2 + 3$ elongate, extending nearly to wing apex. The two crossveins situated rather close together and m located well before middle of wing (fig. 95a). Costa with rather long cilia.

Hennig (1971:42) in his latest discussion of family relationships in the Schizophora sets up a family group "Anthomyzidea" in which he places the families Acartophthalmidae, Clusiidae, Anthomyzidae, Opomyzidae, and Chyromyidae. This group of families is differentiated by having the median portion of the face membranous and usually slightly sunken or furrowed (fig. 94c). These all have just two spermathecae.

These flies are associated with grasses and marsh vegetation. The larvae of some species are known to live in the leaf sheaths of terminal shoots of grasses. Sabrosky (1965a:819) says "larvae have been found associated with *Juncus*, *Typha*, *Elymus*, and so forth, but it is not clear whether they are phytophagous or saprophagous."

The family relationships have been discussed by Hennig (1958, 1971) and the characteristics by Hennig (1939b).

The two genera and species known from Hawaii are differentiated by the following characters.

Two pairs of fronto-orbital bristles. Arista not greatly thickened at base and with long dorsal rays basally followed by alternating rays, as in *Drosophila* (fig. 94a). Legs yellow. Wings with a brown mark at apex and base of vein $M_3 + 4$ lacking, so that cell M and 1st M_2 are confluent (fig. 94b)..... **Amygdalops** Lamb.
thomasseti Lamb.

Only one pair of orbitals. Arista thickened and densely haired basally (fig. 95b). Tibia and first

two tarsomeres of front legs black. Wings entirely hyaline and cell M present, marked off by base of vein $M_3 + 4$ (fig. 95a). **Mumetopia** Melander.
nigrimana (Coquillett).

Genus **AMYGDALOPS** Lamb

Amygdalops Lamb, 1914, Trans. Linn. Soc. Lond. (2)16:357. Type-species, *thomasseti* Lamb, by original designation.

References: Frey, 1958:32 (key).

This genus is characterized by having two pairs of strong reclinate orbital bristles; head quadrate, slightly longer than high with eyes rather elongate and with long axis horizontal (fig. 94a); four distinct rows of acrostichal setae; only one pair of strong dorsocentral bristles and with the anterior dorsocentrals small, setae-like, about one-third the size of the posterior pair and about two times larger than the surrounding setae of the mesonotum. Also, the arista with alternating rays, similar to *Drosophila* and lacking dense pubescence. Palpi rather long, slightly clubbed, each with a prominent apical bristle. Base of vein $M_3 + 4$ lacking so the 1st basal cell is lacking and cell M is confluent with cells 1st M_2 .

Only one known species in Hawaii.

Amygdalops thomasseti Lamb (figs. 94a-e)

Amygdalops thomasseti Lamb, 1914, Trans. Linn. Soc. Lond. (2)16:358.

Type-localities: the following in the Seychelle Islands: Silhouette, Mare aux Cochons; Mahe, near Morne Blanc; marshes on costal plain, Anse aux Pins and Anse Royale; and Praslin, Cotes d'Or Estate.

Oahu, Kauai, Molokai, Hawaii. First recorded from Hawaii, August, 1945 by Wirth (1947:22) as *mumetopia* sp. Later recorded as *Ischnomyia* sp.? (Hardy, 1952a:474), corrected to *Amygdalops* by Hardy (1959).

Immigrant. Seychelles.

No biological data are available.

Differentiated by the generic characters given above and by the presence of a large brown spot in apex of wing (fig. 94b). The upper two-thirds of the front and the occiput are brown. Lower front and face yellow in ground color; the latter with a narrow, silver-gray, pubescent line along each hind margin. Genae yellow, covered with gray pollen. Head shaped as in figure 94a. Antennae yellow, tinged with brown on third segment. Arista with about eight dorsal rays and a small apical fork, also about five rather short ventral rays on apical two-thirds. Mesonotum, scutellum, and upper third of each pleuron dark brown; lower two-thirds of pleuron bright yellow. Stems of halteres yellow, knobs yellow-brown. Legs entirely yellow. Front femur lacking a spine on postero-ventral margin. Wings as in figure 94b. Abdomen entirely dark brown to black. Male genitalia as in figure 94d, surstyli slender, sharp pointed. Female with seventh sternum well developed, almost as long as wide and

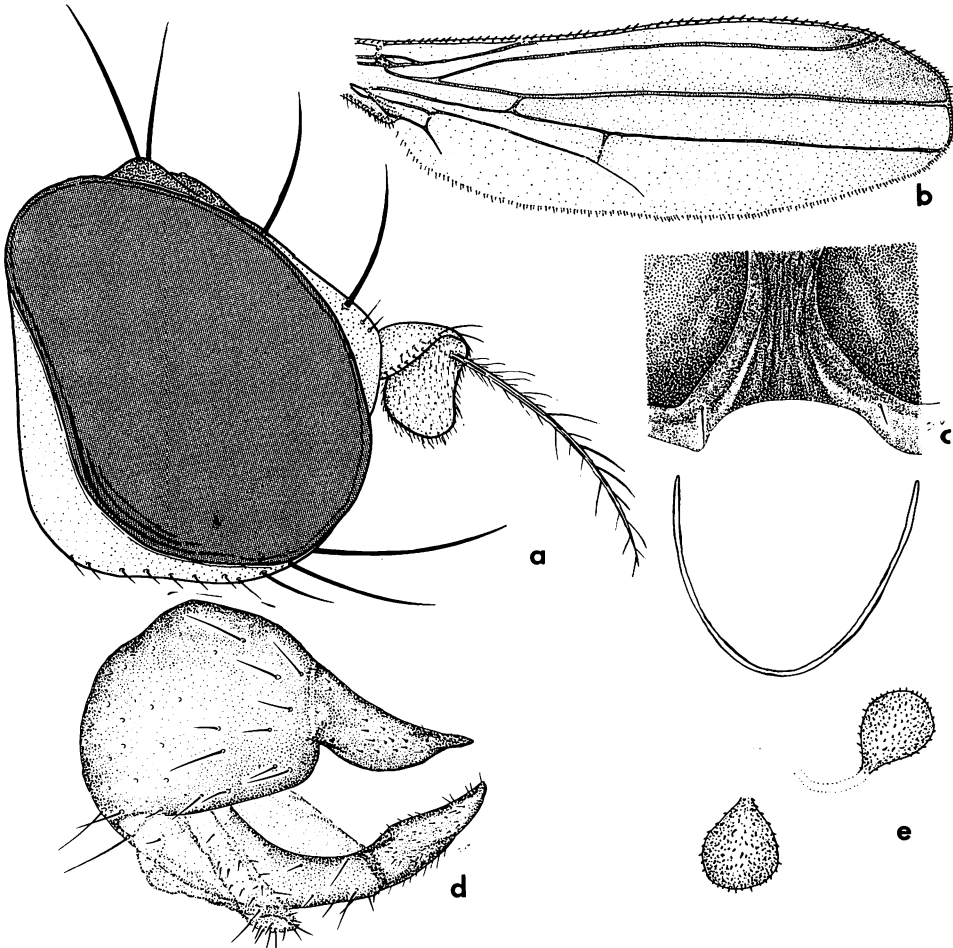


Figure 94—*Amygdalops thomasseti* Lamb: a, head; b, wing; c, facial view; d, male genitalia, lateral; e, spermathecae and atrial sclerotization.

eighth entire. The atrial sclerotization is very faint, difficult to discern, consisting of an elongate, narrow loop extending on sides and connected across venter (fig. 94e). Two black spermathecae; these are spinous, short and thick compared to those of *Mumetopia*.

Length: body and wings, 2.0–2.5 mm.

Genus **MUMETOPIA** Melander

Mumetopia Melander, 1913, J. N.Y. Ent Soc. 21:286, 293. Type-species, *occipitalis* Melander, by original designation.

Characterized by having only one pair of orbital bristles and the frontal triangle very large, polished black, and extending nearly to bases of antennae.

Head slightly higher than long. Eyes large, subquadrate, covering most of head and with face and genae narrow. Arista thickened and densely setose basally (fig. 95b). Ocellar bristles strong, equal in size to outer verticals. Postocellars small but distinct, converging. Two pairs of postsutural dorsocentrals. Apical scutellars strong, secondary pair weak, seta-like. Acrostichal setae very sparse. Two pairs of sternopleural bristles and front femur with a posteroventral spine near apical three-fourths. Base of vein $M_3 + 4$ present closing off the 1st basal cell (M).

Only one species known from Hawaii.

Mumetopia nigrimana (Coquillett) (figs. 95a-d)

Anthomyza nigrimana Coquillett, 1900, Proc. U.S. natn. Mus. 22:264. Type-locality: Utuado and Mayaguez, Puerto Rico.

Reference: Melander, 1913:294 (key).

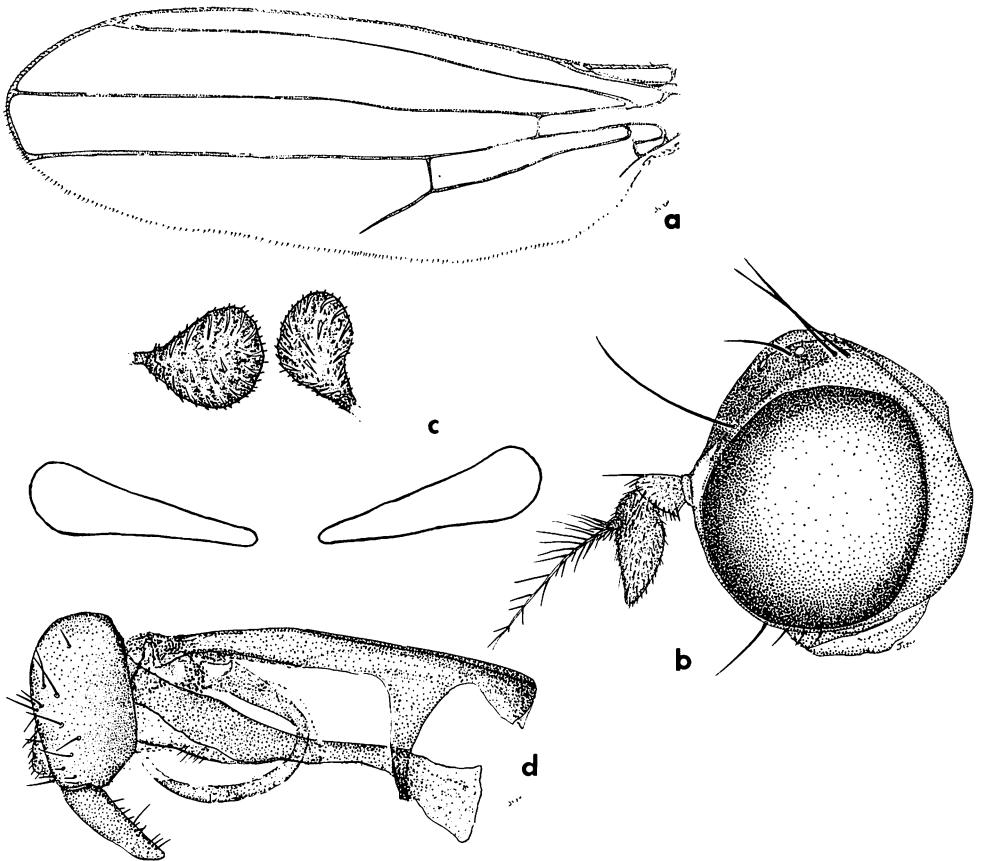


Figure 95—*Mumetopia nigrimana* (Coquillett): a, wing; b, head, lateral; c, spermathecae and atrial sclerotization; d, male genitalia, lateral.

Hawaii, Oahu, Molokai, Lanai. First recorded on the island of Hawaii, June, 1963 (Hardy, 1965:7).

Immigrant. Common over the Neotropical Region; Florida.

Probably a grass infesting species. In Hawaii it has been collected sweeping grasses.

This species is characterized by the black front tibiae and first two front tarsomeres. It is readily differentiated from the other Hawaiian anthomyzids by having just a single pair of large orbital bristles as well as by other generic characters pointed out above.

Head shaped as in figure 95b. Eyes subquadrate, covering a large area of head, and very sparsely pilose. Frontal triangle very large, polished black, extending almost to anterior margin of front. Orbits polished black, from vertex to just below orbital bristles. Lower orbits, face, and genae silvery white pubescent. Face semimembranous down middle and narrowed medianly, at narrowest point slightly less than one-half the width of front. Genae narrow, about equal in width to two rows of eye facets. One pair of strong oral vibrissae plus about four small hairs in the vibrissal row. Occiput entirely polished black. Antennae yellow, tinged faintly with brown over two basal segments. Arista black, densely short haired as in figure 95b. Palpi, long and slender, tinged with brown to black on apical two-thirds. Mentum, very narrow, inconspicuous; yellow, tinged faintly with brown at apex. Mouthparts yellow. Mesonotum and scutellum dark subshining brown, lightly grayish pubescent, and with only one or two presutural setae present and no acrostichal rows. Pleura mostly yellow, tinged with brown over pro and mesopleura. Halteres yellow. Abdomen shining dark brown to black, sometimes with a submedian line of yellow on each side extending from tergum two to about middle of tergum five. Legs yellow except for the black front tibia and the first two tarsomeres, also apical three tarsomeres of front legs white. Wings hyaline, venation as in figure 95a. Male genitalia as in figure 95d. The surstyli rather large, tapered. The hypandrium is very well developed. Seventh tergum of female almost coming together on the venter so that the seventh sternum is very narrow, and weakly sclerotized. Eighth sternum divided into two plates. Atrial sclerotization (walls of genital opening) well developed, conspicuous (fig. 95c); consisting of a long narrow loop on each side, not connected in the middle. Two spiny spermathecae; these are broad at one end, tapered to a rather sharp point on the other and each with a short sclerotized neck.

Length: body, 2.5 mm.; wings, 2.3 mm.

Family ASTEIIDAE

Small to minute flies, readily recognized by the unusual wing venation (fig. 96). The Hawaiian species are differentiated from other acalyptrates by having vein $R_2 + 3$ ending in costa very near apex of R_1 ; r-m crossvein basad in position arising just beyond forking of veins $R_2 + 3$ and $R_4 + 5$; m crossvein and the alula are lacking and veins Cu and A are represented only by rudiments.

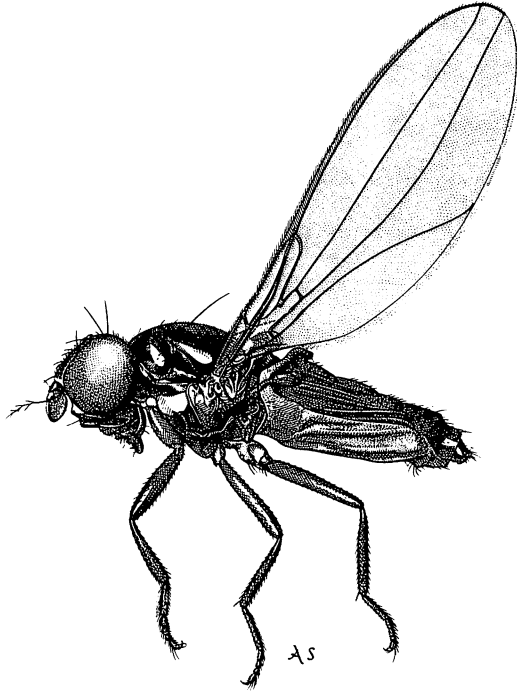


Figure 96—*Asteia hawaiiensis* (Grimshaw): whole drawing.

Veins $R_4 + 5$ and $M_1 + 2$ converge slightly in apex of wing. Third antennal segment short, rounded. Arista bare or with short lateral branches (hairs), sometimes zigzag (fig. 99b), and with arista absent in *Loewimyia* Sabrosky (fig. 106a). The vibrissae are represented by one prominent bristle, plus a row of short hairs. One (two in *Asteia aberrans* n. sp.) pair of strong fronto-orbital bristles present. Mesonotum with two or three pairs of strong dorsocentral bristles. One pair of anterior and one or two pairs of posterior notopleurals and one pair of strong scutellar bristles present. The tibiae lack preapical bristles. Abdomen largely membranous in most Hawaiian species, with the terga and sterna greatly reduced (fig. 96); they are often shriveled in dried specimens.

The costa is entire, but in some Hawaiian specimens a weakened area is evident beyond the humeral crossvein. The posterior portion of the wing is greatly reduced. In Hawaiian species it appears that vein Cu_1 has fused with $M_3 + 4$ and the basal section of $M_3 + 4$ has been lost. A slightly weakened, or paler area on stem of M and at the point where the m-cu crossvein joins $M_3 + 4$ with Cu_1 in most acalyptrates. The anal vein is represented by a small rudiment in posterobasal portion of wing, some times showing as a short thickening along hind margin.

These flies are comparatively rare in collections and practically nothing is

known of their biology. According to Sabrosky (pers. comm.) "asteiids are very often taken on, presumably feeding on fungi. Some are said to develop in debris in hollow trees, and the larvae of one genus [*Liomyza*] have been found in dried stems of *Arundo* in Europe." Lindner (1947:184) indicated that the flies breed in decaying plants. Séguy (1951:702) said that *Liomyza scatophagina* Fallén breeds in dried stems of *Calamagrostis*, *Centaurea*, and *Arundo*, and that *Asteia* breed in rotting vegetation. In Hawaii, two species have been found breeding in decaying limbs of native trees such as *Pisonia*, *Urera*, and *Charpentiera*, also from buds of *Hibiscadelphus*. Adults are often found resting on undersides of horizontal limbs of trees in the forests.

KEY TO GENERA KNOWN FROM HAWAII

1. Arista present (fig. 96); fronto-orbital bristles developed. 2
Arista absent (fig. 106a); no fronto-orbitals.
. **Loewimyia** Sabrosky.
2. Lacking acrostichal setae; mesonotum shining dark brown to black, lightly pollinose, except in *aberrans* n. sp., scutellum largely or entirely dark colored. Front slightly projecting only in *Asteia palikuensis* n. sp. **Asteia** Meigen.
Two rows of acrostichal setae. Thorax and frontal plates heavily gray pruinose. Posterior portion of mesonotum and the scutellum yellow. Front projecting beyond eye, almost the length of third antennal segment (fig. 105a). **Bryanina** Aldrich.

Genus **ASTEIA** Meigen

- Asteia* Meigen, 1830, Syst. Besch. Zweifl. Ins. 6:88. Type-species, *amoena* Meigen, by designation of Westwood (1840:152).
Chaetastia Enderlein, 1935, Mitt. Dt. ent. Ges. 6:47. Type-species, *Asteia sex-setosa* Duda, by original designation.
Plocastia Enderlein, 1935, Mitt. Dt. ent. Ges. 6:47. Type-species, *Asteia decepta* Becker, by original designation.
Eisentrantius Enderlein, 1935, Mitt. Dt. ent. Ges. 6:46. Type-species, *ibizanus* Enderlein, by original designation.
Asteimyia Sabrosky, 1943, Ann. ent. Soc. Am. 96:505. Type-species, *spinosa* Sabrosky, by original designation.

The Hawaiian species of *Asteia* are recognized by having the body mostly brown to black, with yellow markings on pleura; head nearly quadrate, as seen in lateral view, front not projected above antennae except slightly so in *palikuensis* n. sp.; lower portion of face silvery; also by lacking acrostichal setae

on the mesonotum. The male surstyli are asymmetrical with the greater development on the right side (figs. 102c, 103e) and aedeagus as in figures 98a, 99c.

Sabrosky (1957) gives a good discussion of the generic characters and presents a key to the Pacific species.

Four species have been previously described from Hawaii, seven additional new species are being described here. This is obviously a preliminary study, and populations from different islands will very probably prove to be distinct species when we have more knowledge of these flies.

KEY TO KNOWN SPECIES OF HAWAIIAN *ASTEIA*

1. Head as long as high, front gently sloping, and only one pair of fronto-orbital and two vertical bristles. Bristles and setae of dorsocentral rows not converging. 2
 Head higher than long, front strongly oblique, and two pairs of fronto-orbital and only one vertical. Two pairs of strong dorsocentrals plus a row of bristle-like setae continuous with dorsocentrals and converging anteriorly. Northwest Hawaiian Islands. **aberrans** n. sp.
2. With two pairs of posterior notopleural bristles. Scutellum black with yellow apex. Legs usually black. 3
 Only one posterior notopleural. Scutellum entirely dark colored, or entirely yellow. Legs yellow. *sabroskeyi* complex. 8
3. Arista with moderately long, conspicuous side branches; the branches are equal to or longer than the distance between branches and the arista usually distinctly zigzag (figs. 96 and 103b). 4
 Arista with very short, inconspicuous side hairs and straight or nearly so (fig. 102b). 5
4. Vein $R_2 + 3$ ends distinctly in front of R_1 . Two strong and two rather small dorsocentral bristles, i.e., two anterior bristles (strong setae) on each side near suture are nearly one-half as long as the two posterior dorsocentrals. Male aedeagus lacking a preapical appendage and not setose (fig. 103e). Female abdomen with six crossbands (fig. 103d). Maui. **palikuensis** n. sp.
 Vein $R_2 + 3$ joins R_1 at the costa (fig. 96). A row of

- short setae anterior to the strong dorsocentral bristles; the setae are approximately equal in size and about one-fifth as long as dorsocentrals. Aedeagus with a preapical leaf-like process and apex densely setose (fig. 99c). Female abdomen not banded. Hawaii. **hawaiiensis** Grimshaw.
5. Three pairs of strong dorsocentral bristles. Arista straight, bare, or nearly so (fig. 102b). Oahu. **nudiseta** Sabrosky.
Two pairs dorsocentrals. Arista very slightly zigzag, with short (minute) side setae (fig. 98c). 6
6. Pleural area of female abdomen banded with brown (figs. 100a, b, 101a). 7
Sides of female abdomen all yellow, not banded. Male genitalia as in figures 98a, b. Hawaii and possibly Maui. **apicalis** Grimshaw.
7. Sides of female abdomen with six narrow black bands (fig. 101a). Legs yellow. Molokai. **molokaiensis** n. sp.
Sides of abdomen with three short, broad, brown to black bands (figs. 100a, b). Male genitalia as in figure 100c. Femora mostly dark brown. Maui. **mauiensis** n. sp.
8. Hind portion of mesonotum, beyond posterior dorsocentrals, also sides of mesonotum and all of scutellum yellow. Membranous apical portion of male aedeagus elongate, slender not spiculated (fig. 101b) and basal portion of aedeagus with a prominent dorsal appendage. Hawaii. **montgomeryi** n. sp.
Hind portion of mesonotum and scutellum brown to black. Membranous apical portion of aedeagus spiculated (fig. 104a) and basal portion of aedeagus lacking such an appendage. Oahu, also apparently on Kauai, Maui, Molokai. **sabroskyi** n. sp.

***Asteia aberrans* Hardy and Delfinado, new species** (figs. 97a-c)

This species very probably represents a new genus. It differs from other *Asteia* we have seen by having the head higher than long, with the front strongly oblique, and with two pairs of fronto-orbital bristles and only one vertical bristle, rather than the head as high as long, front gently sloping and with only one fronto-orbital and two verticals. The chaetotaxy of the mesonotum is

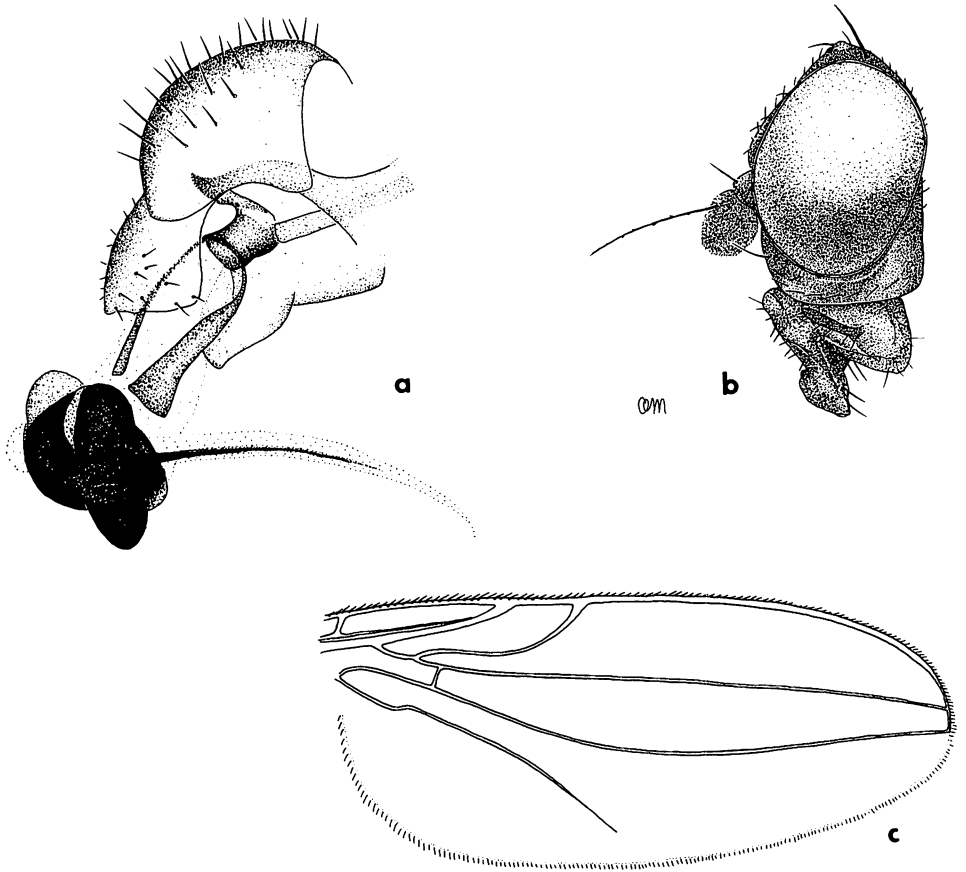


Figure 97—*Asteia aberrans* Hardy and Delfinado, n. sp.: a, male genitalia, right lateral; b, head, lateral; c, wing.

unusual, with two pairs of strong dorsocentral bristles plus a row of bristle-like setae continuous with the dorsocentrals and converging anteriorly. The sides of the mesonotum laterad of the dorsocentral row are rather densely covered with short black setae; much more setose than is usual for asteiids. Also, the front is densely short black setose, somewhat like *sabroskyi* n. sp.; and only one posterior notopleural bristle is present.

From our experience with Hawaiian *Drosophilidae* and knowing what strange developments occur in endemic species, we would prefer to treat this as an aberrant *Asteia* until more evidence which might prove it to represent a distinct genus is available.

MALE. A predominantly black bodied species with thorax rather densely gray pollinose, almost obscuring the ground color. *Head:* As noted above and shaped as in figure 97b, front rufous except for a black vitta extending on each side from vertex to upper fronto-orbital bristle. Measured from median ocellus

to anterior margin, the front is as wide as long; the dense setae are very conspicuous. The frontal bristles are divergent, extending over eye margins, and are about equal to ocellar bristles. The postocellars are also rather well developed and are parallel. The face is strongly sunken in the specimens at hand; it appears to be dark colored but we cannot ascertain whether or not the lower portion is silvery as in other *Asteia*. The antennae are dark brown to black; the aristae are straight or nearly so with short, inconspicuous side hairs. The genae are rufous, rather broad, equal in width to about seven rows of eye facets and rufous in color. One strong oral vibrissa plus a row of black setae. Clypeus and palpi dark brown, the latter prominent and with numerous setae. Mouthparts brownish yellow. *Thorax*: As noted above and with two notopleural bristles and two large plus two small bristles on scutellum. Two rather strong bristles on upper hind portion of sternopleuron, about equal in size to notopleurals. Halteres with brown to black knobs and yellow stems. *Legs*: Mostly dark brown to blackish, tinged with rufous and first three or four tarsomeres yellow. *Wings*: Like most *Asteia*, with vein $R_2 + 3$ ending well beyond R_1 so the third costal section is half as long as the second. Basal section of vein $R_4 + 5$ about equal in length to r-m crossvein and vein $M_1 + 2$ rather strongly concave, narrowing cell R_5 so that at the apex it is about equal in width to the length of r-m (fig. 97c). *Abdomen*: First tergum yellow, tinged with brown. Terga two-five mostly brown and posterior portion and genitalia rufous, tinged faintly with brown. Sternum and conjunctiva yellow. Genitalia as in figure 97a. The surstylus on the left is short, bluntly pointed at apex. The right surstylus is rather quadrate, nearly truncate at apex; and the aedeagus is enlarged into a black, heavily sclerotized mass with a long extension from the apex (fig. 97a).

Length: body (with abdomen relaxed) and wings, 2.5 mm.

FEMALE. Fitting description of male except for genital characters.

Length: body, 2.5–2.7 mm.; wings, 2.5 mm.

Holotype female and two female paratypes. Nihoa Island, Northwest Hawaiian Islands, September 23–24, 1964 (J. W. Beardsley). Allotype male, Necker Island, N. W. Hawaiian Islands, September 26–27, 1964 (J. W. Beardsley).

Type and allotype in B. P. Bishop Museum. Paratypes in University of Hawaii collection.

***Asteia apicalis* Grimshaw (figs. 98a–c)**

Asteia apicalis Grimshaw, 1901, Fauna Hawaiiensis 3:73. Type-locality: Kilauea, Hawaii.

Endemic. Hawaii and possibly Maui.

Resembling *nudiseta* Sabrosky, but readily differentiated by having only two pairs of dorsocentral bristles, rather than three; the male genitalia differ as shown in figures 98b and 101c.

The lower half of the front, the genae, and face are yellow in ground color,

except for the very narrow brown apical margin of the latter. Lower half of face silvery; in perfect specimens the silvery pollinosity obscures the ground color. Upper half of front, vertex, and occiput shining dark brown to black. Third antennal segment brown, tinged with yellow. Arista almost straight, slightly zigzag, and with very short side branches (fig. 98c). One pair anterior notopleurals, two pairs of posterior and of dorsocentral bristles. Scutellum with a large apical yellow spot, occupying area beyond scutellar bristles. Knobs of halteres yellow, tinged faintly with brown. Each pleuron with a broad yellow longitudinal band occupying upper two-thirds to three-fourths of mesopleuron. Legs predominantly or entirely yellow. The abdomen is brown on the dorsum, yellow on sides and venter; no side bands on female abdomen. The terga are moderately developed and the sterna are very lightly sclerotized. Male genitalia as figures 98a, b, with the surstyli rather slender and aedeagus microscopically setose on membranous apical portion.

Average length: body, 2.5 mm.; wings, 3.0 mm.

Sabrosky (1947:56) gave a few descriptive notes on the female.

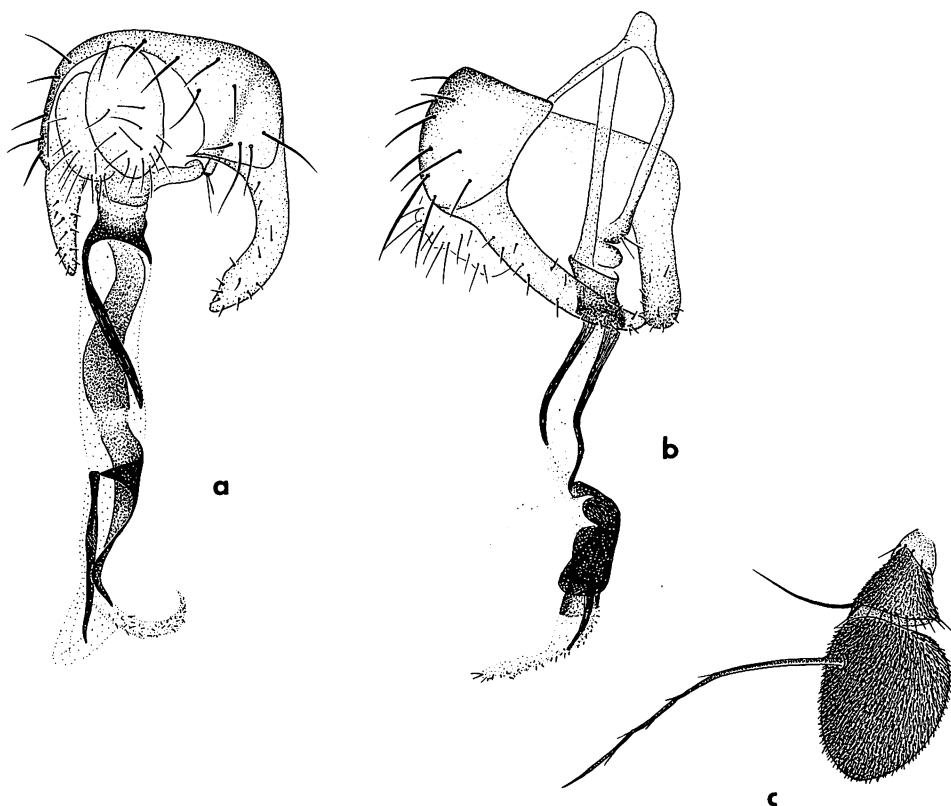


Figure 98—*Asteia apicalis* Grimshaw: a, male genitalia, end view; b, male genitalia, right lateral; c, antenna.

A series on hand from Maui seem to fit here, but the femora and the halteres are tinged with brown. It is probably a distinct species.

***Asteia hawaiiensis* Grimshaw (figs. 96, 99a-c)**

Asteia hawaiiensis Grimshaw, 1901. Fauna Hawaiiensis 3:73.

Endemic. Hawaii (type-locality: Kona). About two dozen specimens have been seen from several localities on the wet slopes of Mauna Loa, Hawaii, 2300–5100 ft. elevation.

Fitting near *palikuensis* complex and differentiated by lacking long bristle-like setae anterior to the dorsocentral bristles, the arista distinctly zigzag (fig. 99b), and by the distinctive structure of the male aedeagus and surstyli (fig. 99c).

Mostly shining dark brown to black, comparatively large species with long branches on the arista (fig. 99b). The third antennal segment with a small,

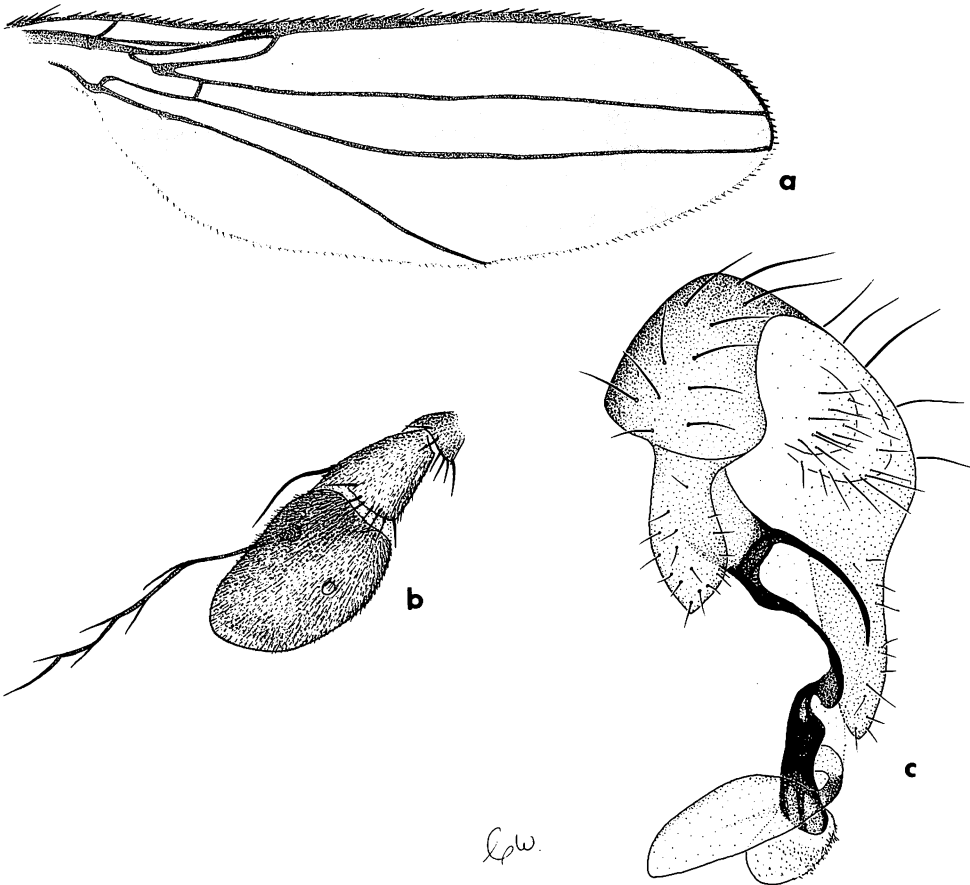


Figure 99—*Asteia hawaiiensis* Grimshaw: a, wing; b, antenna; c, male genitalia, left lateral.

round, pale area (sensory structure?) in lower median portion. 1 + 2 notopleural bristles and 2 strong dorsocentrals, also a row of short, equal size setae situated slightly above the dorsocentral line and extending from the anterior dorsocentral bristle almost to front margin of mesonotum. A broad yellow mark extends across pleuron, over lower half of propleuron and upper portion of mesopleuron to wing base. Also, a narrow mark of yellow extends along upper margin of mesopleuron. Scutellum with a yellow apical spot. Wings smoky, darker fumose than in most *Asteia*. Vein $R_2 + 3$ joins R_1 at apex (fig. 99a). Abdomen with terga and upper margin of conjunctiva black, otherwise yellow, lacking cross bands. First two terga fused into a rather large plate which extrudes over base of third tergum, other terga moderately developed and sterna weakly sclerotized. Male aedeagus tubular, with a prominent leaf-like preapical appendage and with a membranous, sac-like apex which is densely setose. Surstyli broad, with pointed apices (fig. 99c).

Length: body, 3.5–4.0 mm.; wings, 4.0–4.5 mm.

***Asteia mauiensis* Hardy and Delfinado, new species (figs. 100a–c)**

Belonging in the *apicalis* complex and closely related to that species. Differing by having the femora mostly brown (similar in this respect to the dark legged forms of *apicalis*), sides of female abdomen with three short, brown to black bands (figs. 100a and 100b), rather than sides being entirely yellow. The abdominal markings of the female are somewhat like those of *nudiseta*, but the arista is *apicalis*-like. The males are differentiated by the characteristics of the genitalia. The surstyli are asymmetrical: the longest is about equal in length to the epandrium as seen in lateral view, rather than two times longer, as in *apicalis*; the shorter surstylus is much more broad and blunt, about two times longer than wide and slightly expanded apically, rather than being three to four times longer than wide as in *apicalis* (fig. 100c). The aedeagus is bare. This species will also fit near *molokaiensis* n. sp. but differs by the banding on the female abdomen and the predominantly dark brown femora, also by having the sternopleura dark brown to black except for a narrow yellow mark on upper margin.

Holotype female, Waikamoi, Maui, 4000 ft., July, 1956 (R. Namba). Allotype male, same locality as type, July 6, 1966 (D. E. Hardy). Eight paratype females, same locality as type, January–July, 1926–1965 (O. H. Swezey, H. T. Spieth, R. Namba, and D. E. Hardy); Puu Kukui, Maui, June, 1963 (C. R. Joyce) and Iao Valley, Maui, June, 1952, 1500 ft. (D. E. Hardy).

Type and allotype in B. P. Bishop Museum. Paratypes in collections of U.S. National Museum and University of Hawaii.

***Asteia molokaiensis* Hardy and Delfinado, new species (fig. 101a)**

Fitting very near *mauiensis* Hardy and Delfinado, but differing by having six narrow black bands extending over the pleural area on each side of the ab-

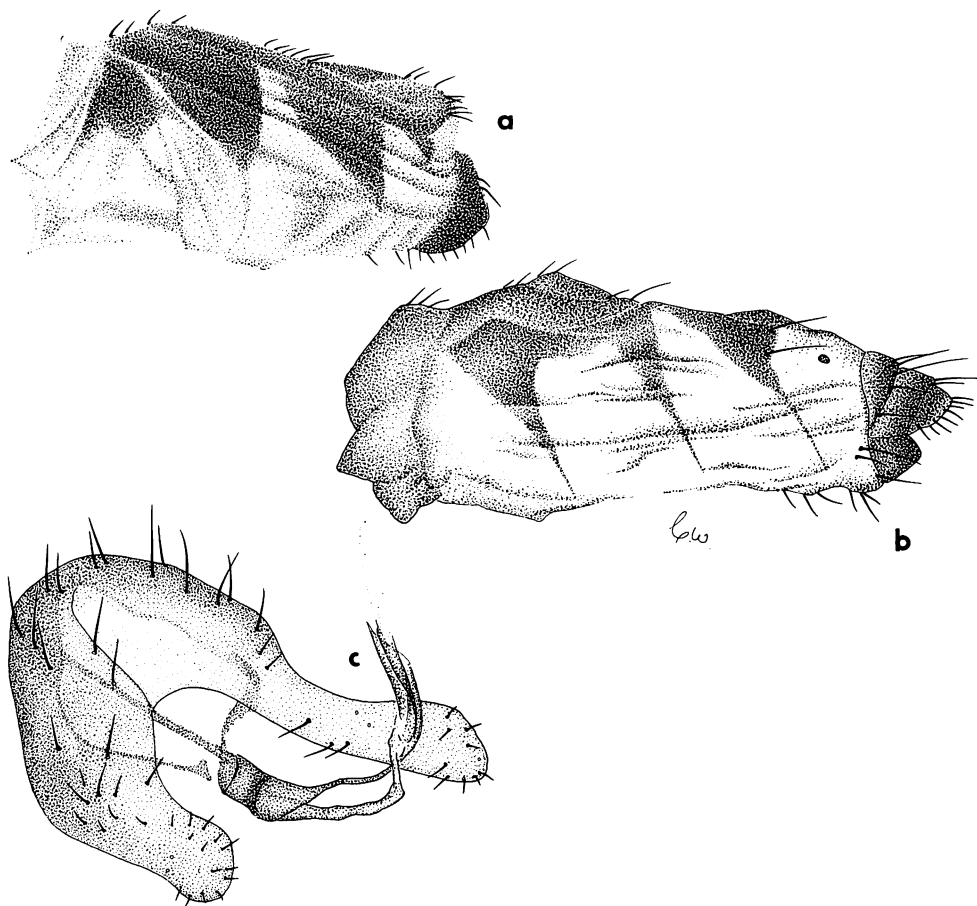


Figure 100—*Asteia mauiensis* Hardy and Delfinado, n. sp.: a, female abdomen, lateral; b, same as a, variation in pattern of dark marks; c, male genitalia, left lateral.

domen of the female (fig. 101a); by having the legs entirely yellow; and the sternopleura predominantly yellow, tinged with brown. The male has not been seen.

Holotype female, Puu Kolekole, Molokai, 3600 ft., July 20, 1964 (D. Gubler). Four female paratypes, same locality as type, June–August, 1952–1964 (D. E. Hardy and M. Tamashiro).

Type in B. P. Bishop Museum. Paratypes in University of Hawaii collection.

***Asteia montgomeryi* Hardy, new species (figs. 101b–c)**

Fitting in the *sabroskyi* complex of species by having only one notopleural bristle, three pairs of strong dorsocentrals, densely setose front, arista with

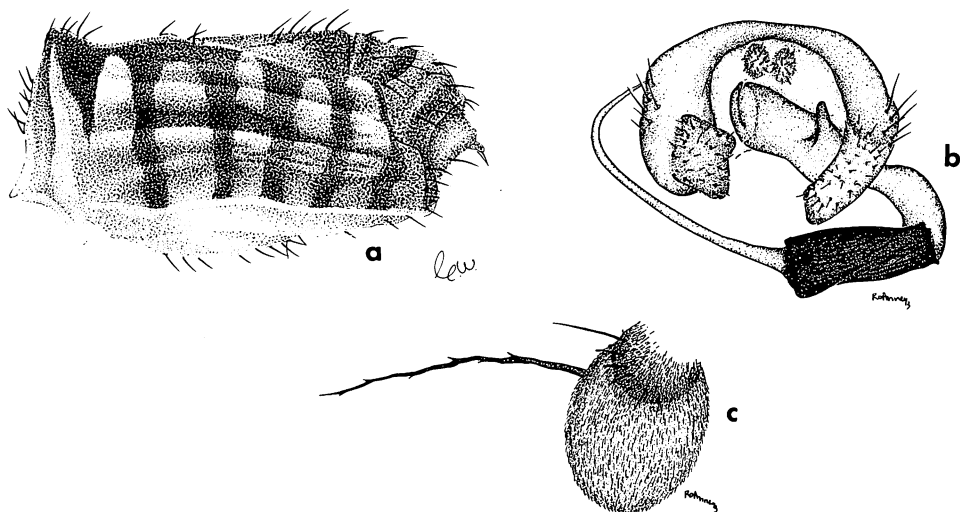


Figure 101—*Asteia molokaiensis* Hardy and Delfinado, n. sp.: a, female abdomen, lateral. *A. montgomeryi* Hardy, n. sp.: b, male genitalia, end view; c, antenna.

minute side branches (fig. 101c), as well as by wing venation, and other characteristics, including ecological ones.

It is differentiated by having the hind portion of the mesonotum beyond posterior dorsocentrals; also, sides of mesonotum and all of the scutellum yellow rather than brown to black. Also, the membranous apical portion of the aedeagus is elongate, slender, not spiculated (fig. 101b), and basal portion of aedeagus with a prominent dorsal appendage.

Otherwise, fitting description of *sabroskyi*. The pleura are almost entirely yellow, with a small spot of brown on upper and lower margins of mesopleuron, median portion of pteropleuron and over lower portion of each sternopleuron and hypopleuron. Abdomen yellow on sides, venter and posterior portion, with rather prominent bristles (strong setae) on posterior margins of last two terga.

Length: body, 1.7 mm.; wings, 2.25 mm.

FEMALE. Unknown.

Holotype male and one male paratype Puuwaawaa, Hawaii, 2000 ft., reared ex *Erythrina sandwicensis* Degener, rotting stems, collected February 16, 1973 (W. B. Heed). Reared by Mr. Steve Montgomery, emerged April–June, 1973.

Type in B. P. Bishop Museum, paratype in University of Hawaii collection.

This species is named after Mr. Steven Montgomery who first discovered the breeding sites of Hawaiian Asteiidae (in close association with the native Drosophilidae) and reared most of the specimens for which we have host information.

***Asteia nudiseta* Sabrosky (figs. 102a-c)**

Asteia sp. Grimshaw, 1901, Fauna Hawaiiensis 3:74.

Asteia nudiseta Sabrosky, 1947, Proc. Haw. Ent. Soc. 13:55 (female). Type-locality: Mount Kaala, Oahu.

Endemic. Oahu. Known from many localities on Oahu, in both the Koolau and Waianae mountains.

Resembling *apicalis*, but readily differentiated by having three strong pairs of dorsocentral bristles and the arista straight, bare, or nearly so; usually with a few microscopic side hairs, difficult to discern. Also, the sides of the female abdomen with two broad bands extending over sides and the terminalia are black.

The original description is adequate. Front brown except for yellow lower one-fourth to one-third. Face densely silvery on lower half. Arista straight, smooth (fig. 102b). One plus two notopleurals, the anterior pair of dorsocen-

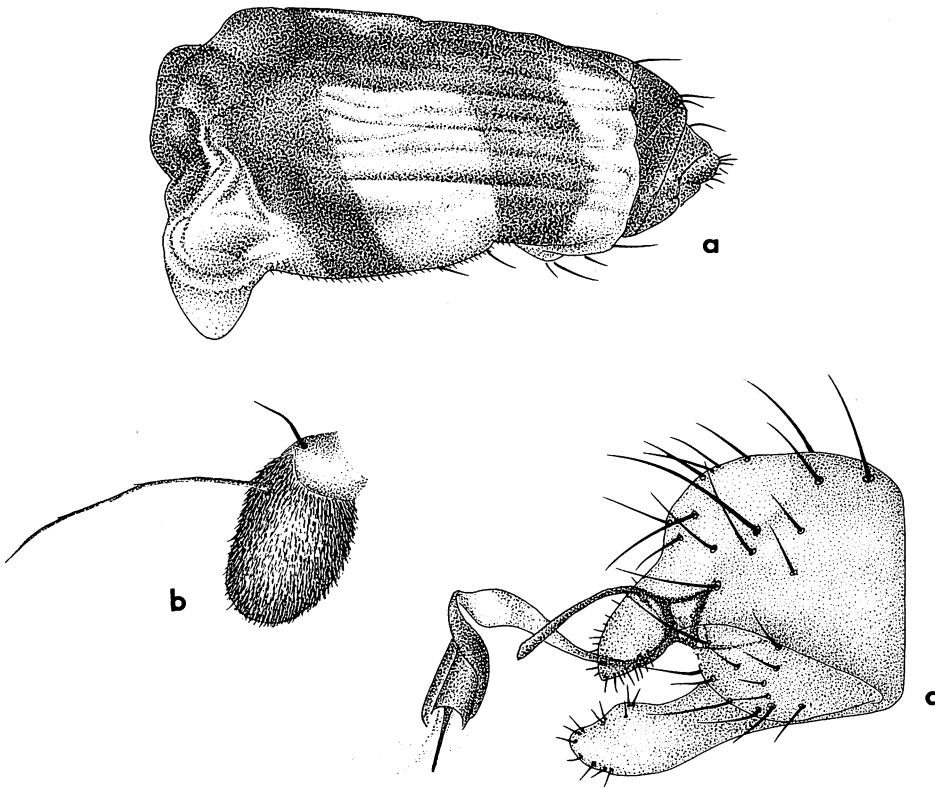


Figure 102—*Asteia nudiseta* Sabrosky: a, female abdomen, lateral; b, antennae; c, male genitalia, left lateral.

trals are presutural in position. Scutellum dark brown except for yellow apical spot. Legs predominantly yellow with distal portions of femora and bases of tibiae dark brown; fifth tarsomere dark brown. The broad yellow band extending longitudinally over each pleuron occupies most of the mesopleuron. Abdomen mostly dark brown over the dorsum and in female with two broad, dark brown to black bands extending around sides as in figure 102a. Terminal portion of abdomen shining black. Male genitalia as in figure 102c, with the surstyli asymmetrical. The one on the left broad and short and the one on the right more elongate, convex on inner margin. The aedeagus with a slender appendage arising from near its base.

Length: body, 2.5-2.75 mm.; wings, 3.0-3.25 mm.

***Asteia palikuensis* Hardy and Delfinado, new species (figs. 103a-f)**

Fitting *hawaiiensis* Grimshaw and differing by having two pairs of prominent bristle-like setae in addition to the regular pair of strong dorsocentrals; by having vein $R_2 + 3$ ending distinctly beyond apex of vein R_1 , the distance between the apices of the two veins is approximately equal to the length of the radial sector; the arista is less distinctly zigzag than in *hawaiiensis*; also by lacking the leaf-like appendage on the aedeagus which is characteristic of *hawaiiensis*; and the surstyli are different in shape, as shown in figure 103e.

MALE. Head: Front slightly protruded anteriorly, as seen from direct lateral view (fig. 103b), somewhat approaching the condition found in *Bryania*. Front black in ground color except for a narrow yellow anterior margin, lightly gray pruinose on lower half, polished above orbital bristles. Orbitals situated slightly in front of a line drawn at margin of anterior ocellus. Face brown, lower two-fifths silvery pollinose. Genae brown, tinged with yellow. Occiput shining dark brown to black. Front densely short setose in area anterior to orbital bristles (fig. 103a). Antennae dark brown, arista with moderately long side branches and slightly zigzag (fig. 103f). Mentum dark brown. Palpi yellow, tinged with brown. **Thorax:** Shining dark brown to black on dorsum, brownish gray pruinose. Humeri brown, apex of scutellum yellow. Knobs of halteres dark brown to black. Each pleuron with a narrow, longitudinal stripe extending from propleuron through middle of mesopleuron to wing base, upper edge of each sternopleuron narrowly yellow. Mesonotum with two prominent bristle-like setae in line with dorsocentrals, situated just before and just after the suture; these are approximately half the length of dorsocentrals. In some specimens, three, and rarely four, strong bristle-like setae are situated before the strong dorsocentral bristles. Only the extreme apex of scutellum yellow, beyond bases of scutellar bristles. **Legs:** Mostly shining brown, tinged faintly with yellow; coxae and trochanters mostly yellow. Each front femur with two moderately developed posterodorsal bristles, one at basal two-fifths and one at basal one-fourth. **Wings:** Distinctly fumose, similar in appearance to *hawaiiensis* except that vein $R_2 + 3$ ends slightly beyond vein R_1 as in figure 103c. **Abdomen:** With the terga well developed and dark brown and the sterna poorly

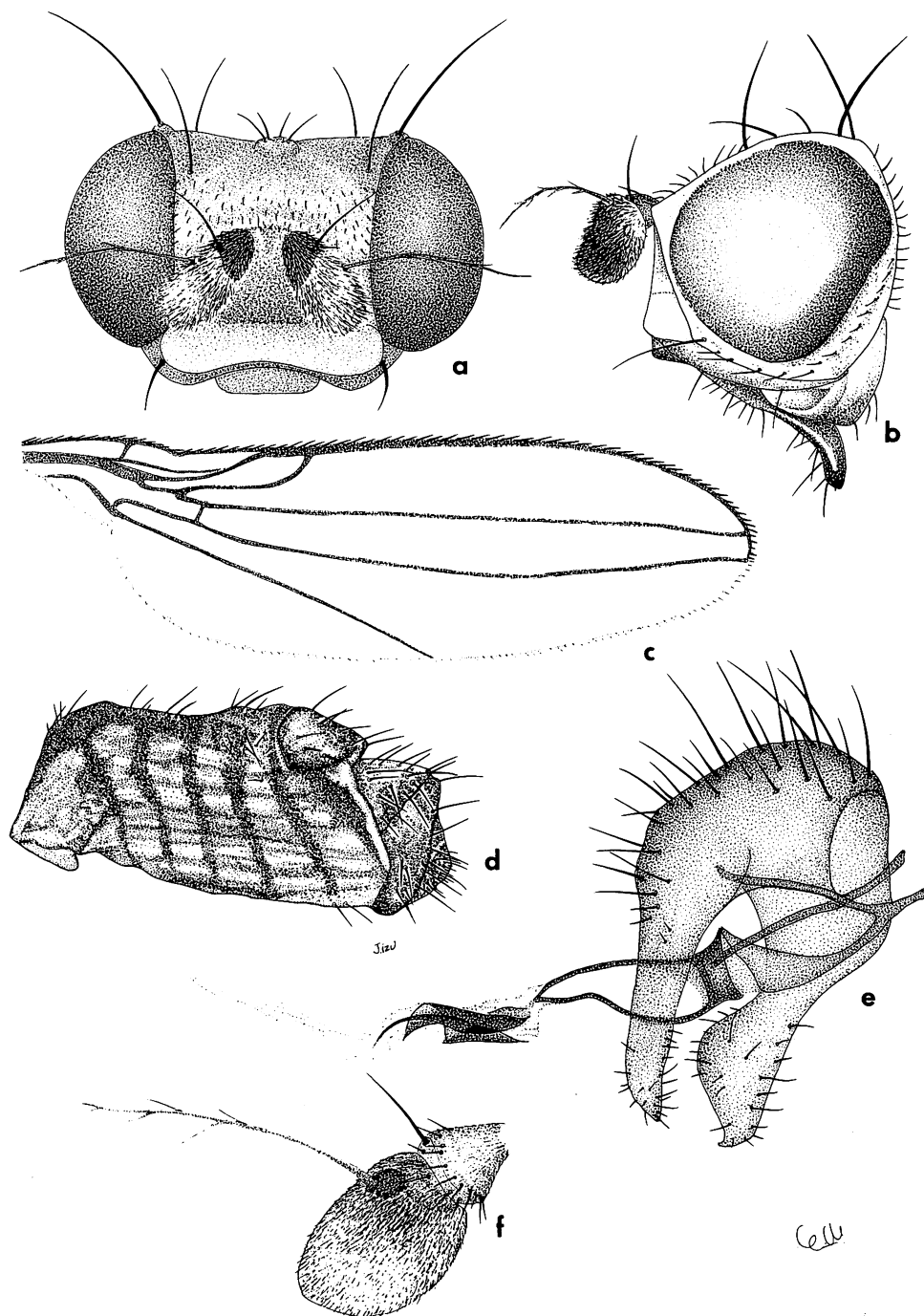


Figure 103—*Asteia palikuensis* Hardy and Delfinado, n. sp.: **a**, head, anterior; **b**, head, lateral; **c**, wing; **d**, female abdomen, lateral; **e**, male genitalia, left lateral; **f**, antenna.

sclerotized, yellow. Male genitalia as in figure 103e. The surstyli are asymmetrical. The one on the right is rather elongate, gently tapered to apex; the left is shorter, rather broadly expanded before apex. The aedeagus terminates in a slender, bare membrane.

Length: body, 2.7–3.0 mm.; wings, 3.7–4.0 mm.

FEMALE. Fitting description of male in most respects. Abdomen prominently banded laterally with six long, very narrow bands extending over sides as in figure 103d. Terga and apical portion of abdomen dark brown.

Holotype male and allotype female, Paliku, Haleakala Crater, Maui, 6500 ft., July 28, 1964 (L. H. Throckmorton). About 200 paratypes, roughly one-third males, two-thirds females predominantly from Paliku, June–August 1952–1965. Many collected swarming, some collected sweeping in grasses and others collected sweeping rather dense vegetation (D. E. Hardy, C. R. Joyce, D. Gubler, J. W. Beardsley, L. H. Throckmorton, and M. Tamashiro). A few of the paratypes from the following localities in Haleakala Crater or on the mountain Haleakala: Holua, 6500 ft., June, 1953 (D. E. Hardy); Kaupo Trail, 5500–6000 ft., July 22, 1965 (J. W. Beardsley), and Oili Puu, July 23, 1965, (J. W. Beardsley).

Type, allotype, and paratype in B. P. Bishop Museum. Other paratypes in collections of U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

Seventeen specimens are on hand from Paliku and one from Hanaula, Maui, 3800 ft., April 16, 1971 (S. L. Montgomery) which seem to fit *palikuen-sis* except that the sides of the female abdomen are not banded. This is probably a distinct species, but has not yet been associated with the male. Female specimens, which agree with the above series but are probably distinct species, are also on hand from Oahu and Lanai.

***Asteia sabroskyi* Hardy and Delfinado, new species (figs. 104a–c)**

Asteia n. sp., Joyce, 1968, Proc. Haw. Ent. Soc. 20:2.

Resembling *nudiseta* Sabrosky by having three pairs of strong dorsocentral bristles. It differs by having only one posterior notopleural bristle; front densely setose; scutellum entirely brown; arista with minute side branches; legs entirely yellow; female abdomen lacking brown lateral bands; and vein $R_2 + 3$ ending much closer to R_1 . Also, the male genitalia are very different as in figures 102c and 104a. The female abdomen is not banded on sides, and the setae of the vibrissal row are much stronger than in other species of Hawaiian *Asteia*. Related to *montgomeryi* n. sp. and differing as pointed out under that species.

MALE. *Head*: Front mostly brown, tinged with yellow on lower portion. Vertex and occiput dark brown to black. Genae yellow and face yellow in ground color except for the narrow, dark brown to black anterior margin and a narrow line of brown across middle, marking upper boundary of the silvery pollinose area. The narrow interfrontal stripes on upper portion of head, op-

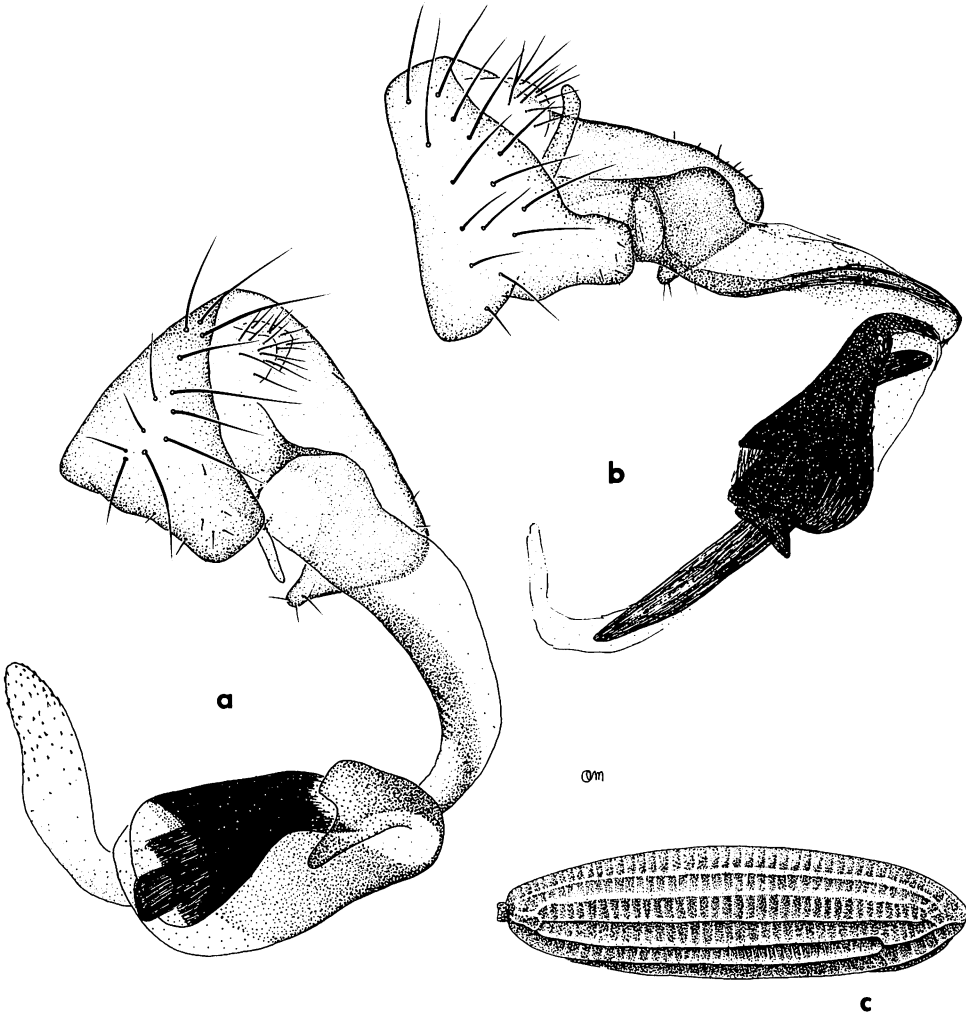


Figure 104—*Asteia sabroskyi* Hardy and Delfinado, n. sp.: a, male genitalia, typical form from Oahu; b, genitalia, specimen from Hawaii; c, egg.

posite ocellar triangle, are rather long, extending from about opposite the fronto-orbital bristles to slightly beyond vertical bristles. Antennae brown, tinged with yellow. Arista straight or nearly so with a few tiny setae on sides; these are sometimes difficult to observe. Front as long as wide, densely black setose. The setae of the vibrissal row are moderately strong, almost half as long as vibrissal bristle. *Thorax*: With mesonotum and scutellum dark brown, subshining, lightly gray-brown pruinose. Pleura mostly yellow with a narrow brown mark across upper portion of each sternopleuron, along lower portion of mesopleuron, across pteropleuron, and another brown streak across middle

of sternopleuron. Knobs of halteres brown, stems yellow. Only one posterior notopleural bristle present. Three pairs of strong dorsocentrals, one pair presutural, and with a row of about four prominent erect setae extending between the anterior two pairs of dorsocentral bristles and three setae in front of the anterior dorsocentral, in line with these bristles. Scutellum with a small secondary seta on each lateral margin; in one specimen which has been seen, one of these is enlarged, bristle-like. Three prominent bristles on upper portion of each sternopleuron. *Legs*: Predominantly or entirely yellow. Each front femur with two moderately strong posterior bristles near base of segment and one posterodorsal bristle at middle. *Wings*: As in other species of this genus except that vein $R_2 + 3$ ends immediately beyond end of R_1 rather similar to *hawaiiensis*; also, the apical portion of cell R_5 is comparatively narrow, about equal or slightly less than half the width of this cell at its widest point. *Abdomen*: First tergum tinged with yellow and apex of abdomen yellow, otherwise brown as seen from dorsal view. Sides and venter yellow, sterna weakly sclerotized. Genitalia as in figure 104a with the surstyli asymmetrical, rather small, the one on the left short, nearly quadrate in shape, and the one on the right convex on dorsal surface, beak-like at apex. Aedeagus very large, much larger than other species which we have seen, and the apex is prolonged into a slender, spiculated membranous area (fig. 104a). Specimens from the island of Hawaii have the apical portion sclerotized and nearly devoid of spicules (fig. 104b). This probably represents a distinct species.

Length: body, 2.25–2.5 mm.; wings, 2.85–3.25 mm.

FEMALE. Fitting description of male except for genital characters. This is one of the most common species and is probably on all of the main islands. It breeds in rotting bark in various native trees and has been reared from rotting bark and stems of *Pisonia*, *Charpentiera*, and *Urera*, and from seed pods of *Hibiscadelphus*. It breeds in close association with native *Drosophila* and *Dolichopodidae*.

Immature stages. As far as we know no immature stages of asteids have been previously described and figured. *Egg*: Laid singly on the bark and in crevices of bark. White, about 0.5 mm. long, 0.13 mm. greatest width or four times as long as wide; with terminal tubercle, delicately reticulate chorionic pattern (like a corn cob) (fig. 104c). The association of the larva is not yet definite. *Puparium*: About 1.25 mm. long. Yellowish brown, each cylindrical, slightly flattened dorsocentrally—with depressed cephalic cap. Integument shiny, finely wrinkled, with faint sandy-grained texture. Posterior end subtruncate with a small median shallow depression dorsally. Posterior spiracles tubular, protruding, anterior spiracles sessile, lying on lateral margins of cephalic cap.

Holotype male and allotype female, Mt. Tantalus, Oahu, January 1, 1970 (reared ex rotten stem of *Pisonia*) (S. L. Montgomery). Ca. 125 paratypes, both sexes about evenly represented from the following localities on Oahu; same as type, also May 5, 1956 (J. W. Beardsley and S. L. Montgomery): Mokuleia, November 23, 1970, ex rotten bark *Pisonia* (Montgomery); Puu

Pane, June 18, 1970 (S. L. Montgomery); Puu Kaua, August 4-27, 1970, ex *Pisonia* and *Urera* stem (S. L. Montgomery); Palikea Gulch, February 20, 1970, ex rotten stem *Pisonia* (S. L. Montgomery); Puu Kanehoa, Waianae Mts., July 25-August 10, 1959 and February 21, 1971 (J. W. Beardsley and S. L. Montgomery); E. Makaleha, December 7, 1969 and November 7, 1970, ex reared *Pisonia* stem (S. L. Montgomery); Waianae Kai Forest Res., 1800 ft., May 31, 1970, ex hibiscus bark (S. L. Montgomery); Kaluaa, February 15, 1970, ex rotten branch *Urera* and *Charpentiera*; Nuuanu, July 10, 1961, April 6, 1959, January 26, 1959 (C. R. Joyce); Honolulu, August 8, 1958, January 13, 1958 (C. R. Joyce); Opaepala, June 20-July 16, 1970, ex *Pisonia* stems (S. L. Montgomery); Mt. Kaala, June 30, 1963 (L. H. Throckmorton); Waimano Trail, 400-500 m., July 5, 1963 (J. L. Gressitt); Waiawa, June 8, 1921 (Swezey); Manoa, March 12, 1945; Niu, 1600 ft., July 11, 1971, ex *Pisonia* stems (S. L. Montgomery); Paliku Gulch, February 20, 1970, ex rotten stem of *Pisonia* (S. L. Montgomery); and Honolulu, January 13, 1958 (C. R. Joyce).

Over fifty specimens are also on hand from the following localities on other Islands. These appear to be *sabroskyi*, but may possibly represent one or more distinct species. These are not being designated as paratypes.

Kauai: Alakai, Kokee, 4000 ft., September 14, 1965 (C. M. Yoshimoto); Kokee, 8600 ft.; July, 1953 (D. E. Hardy); Mohihi Stream, Kokee, July 27, 1963, August 28, 1964 (Hardy, Spieth, Throckmorton); Nualolo Valley, 3400 ft., July, 1952 (D. E. Hardy); Halemanu Valley, August, 1953 (Hardy); Kawaikoi Stream, 3700 ft., August, 1953 (Hardy). Hawaii: Kipuka Ki, September 8, 1964 (Spieth); Bird Park, Kilauea, June 24, 1963 (Throckmorton); Hualalai, 2000 ft., August 18, 1964 (Hardy); Pauahi, 4300 ft., August, 1956 (Hardy); N. Kona, Puuwaawaa, 3700 ft. (W. M. Giffard); Waimea, April 26, 1944 (Krauss); Moana Loa Truck Trail, 4250 ft., November, 1956 (W. Mitchell). Molokai: Maunawainui Valley, July, 1952 (Hardy). Maui: Kaupo Gap, 4800 ft., April 21, 1971, reared ex *Pisonia* stem (Montgomery); and Ulupalakua, May 26; 1965 (J. W. Beardsley).

Type, allotype, and some paratypes in B. P. Bishop Museum. Other paratypes in collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

Genus **BRYANIA** Aldrich

Bryania Aldrich, 1931, Proc. Haw. Ent. Soc. 7(3):397. Type-species, *bipunctata* Aldrich, by original designation.

Differentiated from *Asteia* by having two rows of acrostichal setae on the mesonotum, in combination with the anterior portion of the front produced beyond eye, almost the length of third antennal segment; thorax and orbital plates densely gray pruinose, and scutellum and hind portion of mesonotum yellow.

Only one known species.

***Bryania bipunctata* Aldrich (figs. 105a-c)**

Bryania bipunctata Aldrich, 1931, Proc. Haw. Ent. Soc. 7(3):397. Type-locality: Nihoa Island.

Endemic. Northwest Hawaiian Islands, Layson and Kure Islands (Hardy, 1967:326). Previous records from Oahu pertain to specimens of *Stenomicroa orientalis*.

Readily recognized by the generic characters given above. Mostly yellow, densely gray pollinose species. Head slightly longer than high, mostly yellow-white in ground color, except for a prominent brown spot on each side on the protruded portion of front just above antennae and another dark brown spot on each side at middle of occiput. Frontal plates elongate, extending almost to a level with anterior margin of compound eye and densely pruinose. Face with a pair of small brown to black spots in middle (fig. 105b). In males the eyes are almost circular, just slightly longer than high with genae one-fourth to one-fifth the eye height. In the female the eyes are longer than high and the genae are comparatively broad, at least half the eye height (fig. 105a). The third

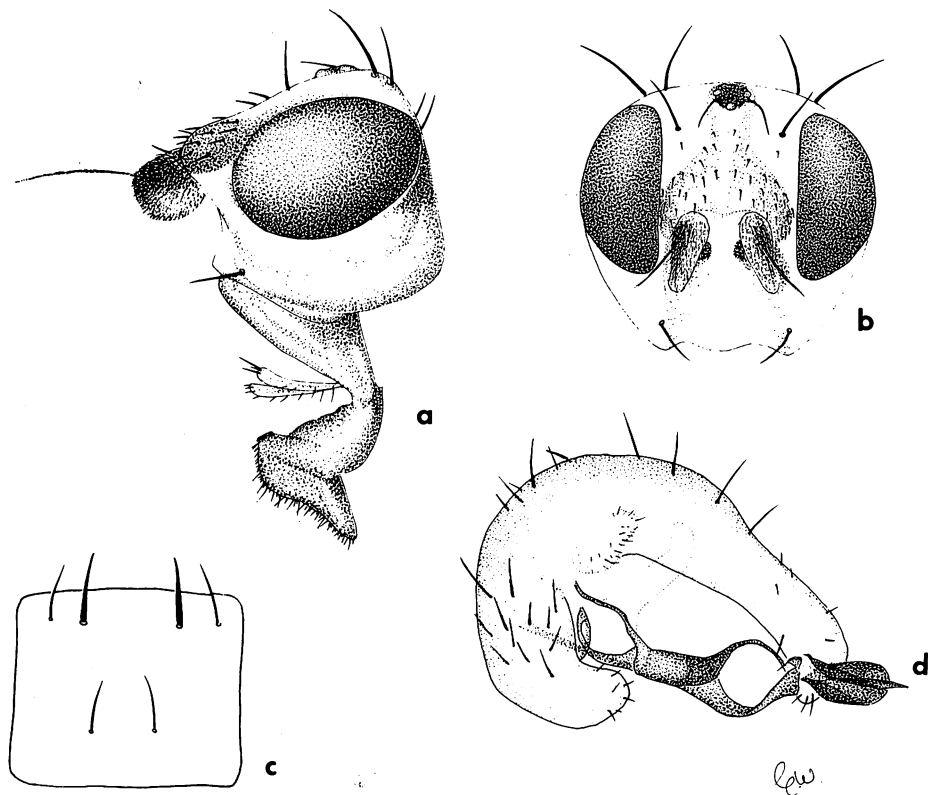


Figure 105—*Bryania bipunctata* Aldrich: a, head, lateral; b, head, anterior; c, last tergum of female abdomen; d, male genitalia, left lateral.

antennal segment orbicular, yellow at apex, dark brown to black on basal two-thirds. Arista short, scarcely two times longer than width of third segment, with very short inconspicuous branches. Palpi pale yellow, slender, with numerous yellow setae over outside and apical margins. Mesonotum predominantly yellow in ground color, densely cinereous, with two pairs of brown to black vittae extending over anterior portion; the median pair extending from anterior margin almost halfway between the two pairs of dorsocentrals and the lateral pairs extending to or slightly beyond posterior dorsocentrals. Humeri and notopleura tinged with brown. Pleura mostly yellow with a brown spot on upper mesopleuron. Halteres yellow, faintly tinged with brown at apices. Two pairs strong dorsocentrals and two rows of acrostichal setae, especially conspicuous on anterior half of mesonotum and sparsely arranged on posterior portion. One anterior notopleural and one posterior notopleural bristle. Legs entirely yellow. Wings hyaline, venation similar to that of *Asteia*. Apices of veins R_1 and $R_2 + 3$ dark brown, and also with a dark brown spot on costa at the junction of these veins. Abdomen mostly yellow, terga narrow, rather weakly sclerotized. Sterna apparently not developed. Male genitalia as in figure 105d, with the surstyli asymmetrical, the one on the left poorly developed, small, and rounded and the right moderately developed. Aedeagus stout, well sclerotized. Last tergum of female with six stout setae arranged as in figure 105c.

Length: body and wings, 2.0–2.3 mm.

Genus **LOEWIMYIA** Sabrosky

Loewimyia Sabrosky, 1943, Ann. Ent. Soc. Amer. 36:503. Type-species, *bifurcata* Sabrosky, by original designation.

Minute species with wing venation similar to that of *Asteia* but differentiated by lacking an arista, having the third antennal segment densely fringed with long hairs and with the margin minutely serrate (fig. 106a), and mesonotum with only one pair of dorsocentral bristles.

Previously known only from the type, although Sabrosky (1957b:48) indicated other undescribed species were on hand. It is apparently a New World genus.

***Loewimyia orbiculata* Hardy, new species** (figs. 106a–c)

Very similar to *bifurcata* Sabrosky, but with the third antennal segment orbicular (fig. 106a) or nearly so, with a very shallow marginal concavity but not bifurcate, deeply notched apically (ref. Sabrosky, 1943a:504, fig. 2). Also, the description of *bifurcata* indicates that the head is brown to blackish except for the yellow face, genae, palpi, and proboscis. In *orbiculata* the front is rufous. The size is slightly larger: body 1.25 mm., wings, 1.3 mm., compared to 0.6 mm. for body and 0.8 mm. for wings. Otherwise fitting the brief description of *bifurcata*. The male genitalia were not examined.

MALE. Tiny, mostly dark brown species. *Head*: About one-third higher than

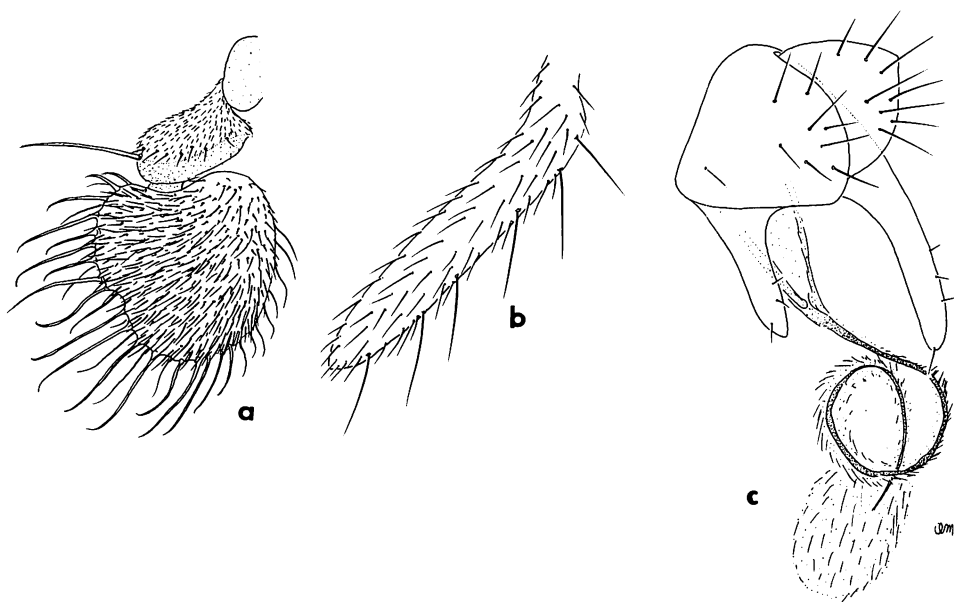


Figure 106—*Loewimyia orbiculata* Hardy, n. sp.: a, antenna; b, palpus; c, male genitalia, left lateral.

long, as seen from lateral view, occupied almost entirely by the compound eyes with a small bit of the vertex and narrow occiput and gena visible. Front slightly depressed so ocelli are hidden from direct lateral view. In the median portion, the gena is about equal in width to two rows of eye facets. Genae and face white; rim of occiput pale yellow, hind portion tinged brown to blackish; front rufous and ocellar triangle reddish brown, tinged with black. Ocellar triangle extending well below middle of front; the portion of the front below median ocellus very narrow, four times wider than long. Two rather well-developed brown oral vibrissae; front lacking bristles or setae; ocellar bristles rather small about equal in size to dorsal bristles on second antennal segment, brown; vertical bristles well developed, black. Antennae yellow, tinged with brown to black, third segment large, nearly orbicular, shaped as in figure 106a; the margin is irregular and with prominent setae. Palpi tiny, slender (fig. 106b), scarcely visible *in situ*. *Thorax*: Mostly brown to blackish, tinged with rufous in the ground color and gray pollinose. Two small, black notopleural bristles; one small supraalar and one postalar; two large dorsocentrals, situated at hind third of mesonotum and two large scutellars. Two rows of short acrostichal setae; one row of brown setae down each dorsocentral line, and with scattered short black setae on sides of mesonotum. A pair of small black bristles also present near upper hind margin of each sternopleuron. Halteres yellow, tinged with brown on their knobs. *Legs*: Yellow with faint rings of brown to blackish on mid and hind femora and tibiae. *Wings*: As described and figured for *bifurcata* (Sabrosky, 1943a:504, fig. 1). *Abdomen*: Dark brown to black, gray

pollinose and sparsely setose. Genitalia largely pale yellow; the structures are difficult to discern except under compound microscope. The surstyli are simple, rather slender. The aedeagus is largely membranous, the apical portion microscopically haired (fig. 106c) and very different in development from other Hawaiian Asteiidae.

Length: body, 1.25 mm.; wings, 1.3 mm.

FEMALE. As in male except for genital characters. Posterior portion of abdomen yellow.

Holotype male, Barber's Point, Oahu, December 29, 1965 (J. W. Beardsley). Allotype female, Honolulu, Oahu, January 3, 1966 (C. R. Joyce). Nine paratypes: four males, five females same locality as allotype, September 1965–January 1967, collected in light traps (C. R. Joyce); Waipahu, Oahu, September 23, 1965 (J. W. Beardsley); Waipio Peninsula, Oahu, November 24, 1965 (J. W. Beardsley); Ewa, Oahu, September 23, 1965 (J. W. Beardsley).

Type, allotype, and some paratypes in B. P. Bishop Museum. Remainder of paratypes in collections of the U.S. National Museum and the University of Hawaii.

Family EPHYDRIDAE Shore Flies

The family Ephydriidae consists of relatively small acalyptrate flies which are cosmopolitan in distribution. The adults have been most commonly characterized as having a prominent face and a large mouth opening (fig. 107). While these characters may be typical of the subfamily Ephydrinae, they reflect very little the typical features of the other three subfamilies (Notiphilinae, Parydrinae, and Psilopinae). The family may be more inclusively characterized as follows: face usually prominent, bare or hairy; mouth opening generally large and gaping, its margin sometimes lined with long hairs, or mouth opening small with its margin bare; vibrissae absent, although the ventral-most facials may be located near the vicinity of the vibrissal angle of the face; and arista plumose or minutely pubescent—if plumose, the hairs are borne dorsally only; wings with the costa broken at humeral crossvein and near apex of vein R_1 ; subcosta reduced, either evanescent near its base or fused with the first vein throughout most of its length, second basal and discal cells confluent; cubital cell absent; and anal vein reduced or absent. For morphological details of head, thorax, and abdomen, refer to figures 108–110.

In general, ephydrids are associated with various kinds of aquatic and semi-aquatic habitats; the larvae living either as scavengers on decaying organic material and microorganisms or as miners or borers in aquatic plants. The name "shore flies" has been given to the adults of these insects primarily

This section on the Ephydriidae was prepared by Joaquin A. Tenorio, B. P. Bishop Museum, Honolulu, Hawaii.

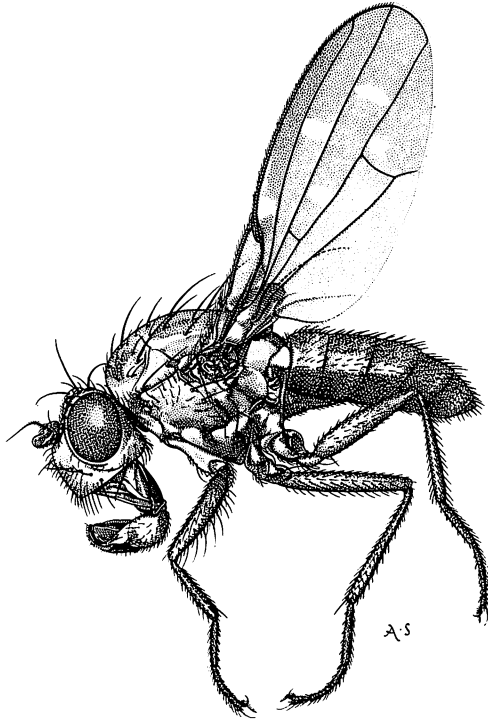


Figure 107—*Neoscatella sexnotata* (Cresson): whole drawing.

because they commonly occur on seashores, shores of lakes, rivers, streams, and ponds.

The first report of an ephydrid in the Hawaiian Islands was made by Howard (1901) in which he recorded *Brachydeutera argentata* (Walker) from the island of Hawaii. The report of this species was based on a misidentification which was not corrected until Cresson (1926) recognized it as new and named it *Brachydeutera hebes* Cresson.

While it was Howard who first revealed the presence of Ephydridae in the Hawaiian Islands, Grimshaw was the first to study the taxonomy of these flies in the islands. In *Fauna Hawaiiensis*, Grimshaw (1901) described two new species, *Notiphila insularis* and *Scatella hawaiiensis*, both from the island of Oahu, and also reported the same species recorded earlier by Howard.

In 1914, Illingworth reported the misidentified *B. argentata* for the first time from Molokai, Maui, and Oahu and presented brief notes on the adult and larval habits, including a description of the pupa.

Descriptions of the larva and pupa of *Ilythea* sp. from Oahu were presented by Warren (1914). Warren, however, had placed the species in the wrong genus, and Cresson (1926) subsequently described the species as *Scatella warreni*.

KEY TO ABBREVIATIONS FOR FIGURES 108-110

ac	acrostichal bristles	iv	inner vertical bristles
aed	aedeagus	mes	mesopleura
aed. ap.	aedeagal apodeme	mesb	mesopleural bristles
aia	anterior intraalar bristles	not	notopleura
cer	cercus	np	notopleural bristles
cl	clasper	oc	ocellar bristles
cox	coxa	ov	outer vertical bristles
dc	dorsocentral bristles	or	oral bristles
ep	epandrium	pa	postalar bristles
fac	facial bristles	pia	posterior intraalar bristles
fac. h.	facial hump (facial tubercle)	po	postocellar bristles
fac. set.	facial setulae	pre	presutural bristles
fo	fronto-orbital bristles	presc. ac.	prescutellar acrostichals
ge	genal bristles	presc. dc.	prescutellar dorsocentrals
ge. set.	genal setulae	pro	propleura
hu	humeral bristles	pter	pteropleura
hyp	hypandrium	sa	supraalar bristles
hypo	hypopleura	sc	scutellar bristles
if	interfrontal bristles	ster	sternopleura

Fullaway (1914) reported *Scatella hawaiiensis* var. *sexnotata* Terry from Laysan Island. This name was a manuscript name of Terry's, as pointed out by Cresson (1926) when he described the species as distinct and named it *Scatella sexnotata*.

Discomyza maculipennis (Wiedemann) was added to the Hawaiian ephydrid fauna by Bryan (1926) when he reported specimens from improperly cleaned sea shells from the Whippoorwill Expedition and from specimens collected on Oahu in 1917 and 1922.

Cresson (1926) described *Scatella terryi* from Oahu and *S. bryani* from Kauai and Oahu, in addition to the above-mentioned *S. sexnotata*, *S. warreni*, and *B. hebes*.

A new species, *Atissa antennalis*, was described by Aldrich (1931) from specimens collected on Necker Island by E. H. Bryan.

Hecamede albicans (Meigen) was reported from Kahoolawe Island swept from salt bush on February 14, 1931 (Bryan, 1933). This species was subsequently reported from Oahu by Cresson (1945) as *Hecamede persimilis* Hendel. The identification of Cresson was later confirmed by W. W. Wirth, and the findings reported by Adachi (1954).

Bryan (1934) presented a list of the Hawaiian Ephydridae, citing 10 species. In this list, Bryan used the name *Paralimna insularis* (Grimshaw) in place of

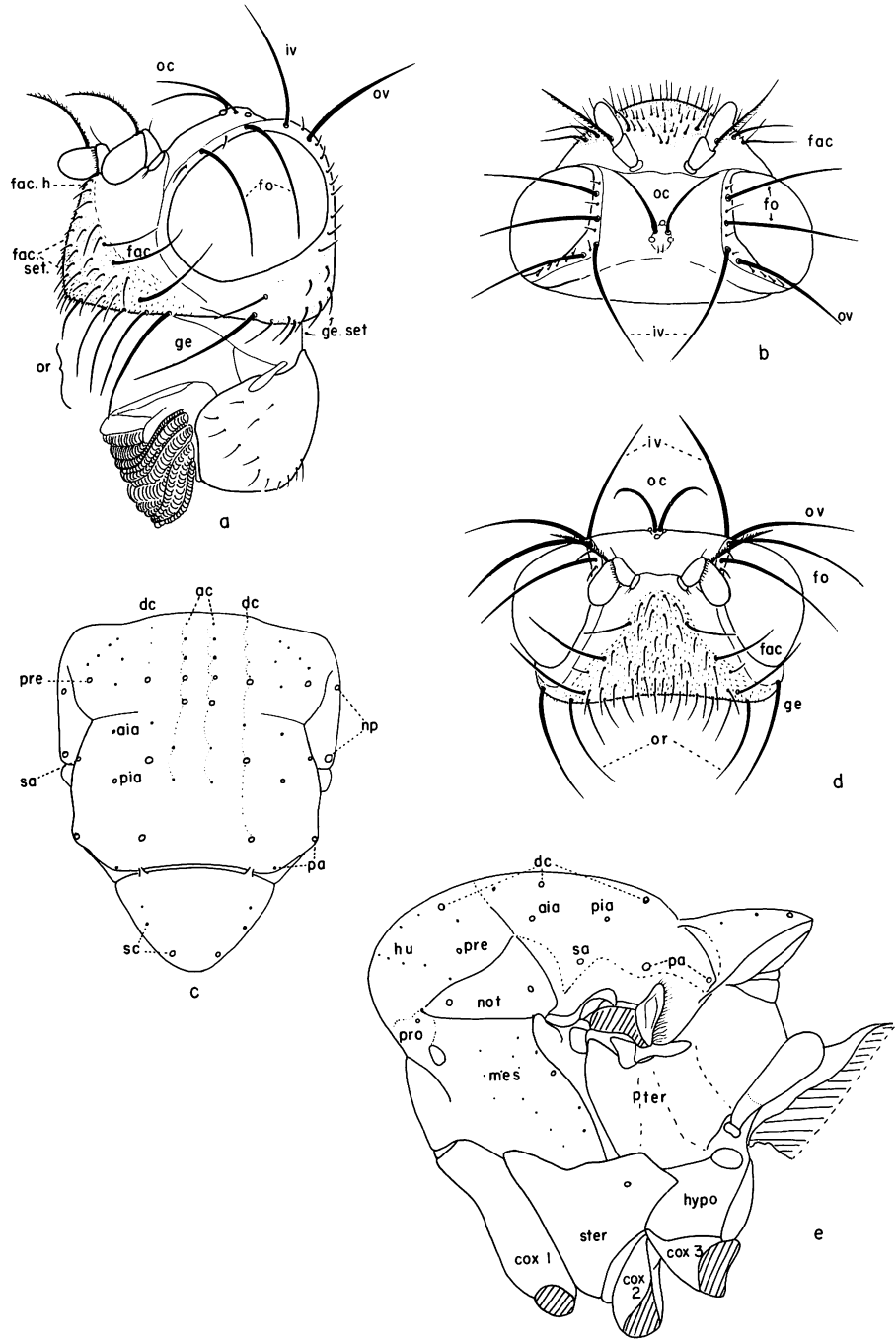


Figure 108—*Neoscatella* sp.: a, head, lateral; b, head, dorsal; c, thorax, dorsal; d, head, anterior; e, thorax, lateral.

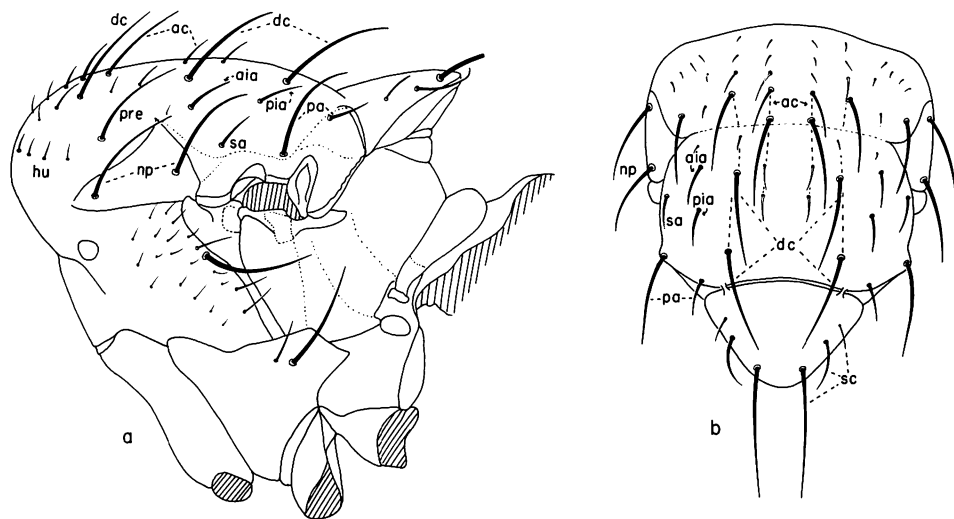


Figure 109—*Neoscatella* sp.: a, thorax, lateral; b, thorax, dorsal.

Notiphila insularis Grimshaw. The latter name was later reinstated by Hardy (1952) upon confirmation of the correct genus by W. W. Wirth.

In 1935, Cresson transferred the five known species of Hawaiian *Scatella* to the new genus *Neoscatella* proposed by Malloch in the same year.

Two more new species, both from the island of Oahu, were described by Cresson (1936) as *Hydrellia hawaiiensis* and *H. williamsi*, the latter species a leaf-miner in duckweed (prob. *Lemna*).

Williams (1938), in his notable biological studies of water-loving insects of Hawaii, discussed the biology of nine ephydrid species, including *S. oahuense*, which he described as new. Many of Williams' biological observations and excellent illustrations show great attention to detail and extraordinary patience. His work is the most interesting and comprehensive account of Hawaiian ephydrid biology available.

Ephydra gracilis Packard was reported by Wirth (1947) breeding in large numbers in salt water ponds near Moanalua Gardens on Oahu. At the same time, Wirth presented a discussion of the habits of the adults and immature stages of this species. Through correspondence with Dr. D. E. Hardy, Wirth later advised that the reported *E. gracilis* was, in fact, *E. cinerea* Jones.

Wirth (1947) subsequently reported *Scatella* sp. from Kauai, *Hecamede femoralis* Malloch from Oahu, and a *Chaetoscatella* sp. as probably endemic. The *Scatella* sp. was later described by Wirth (1948) as *Neoscatella kauaiensis*, and, in the same paper, he described the *Chaetoscatella* sp. as a new species of *Apulvillus* Malloch, synonymizing *Chaetoscatella* Malloch with *Apulvillus* Malloch. *H. femoralis* is a synonym of *H. persimilis* Hendel, according to Cresson (1948).

In 1948, Cresson described *Atissa oahuensis* from Oahu, the second species of *Atissa* known from the islands.

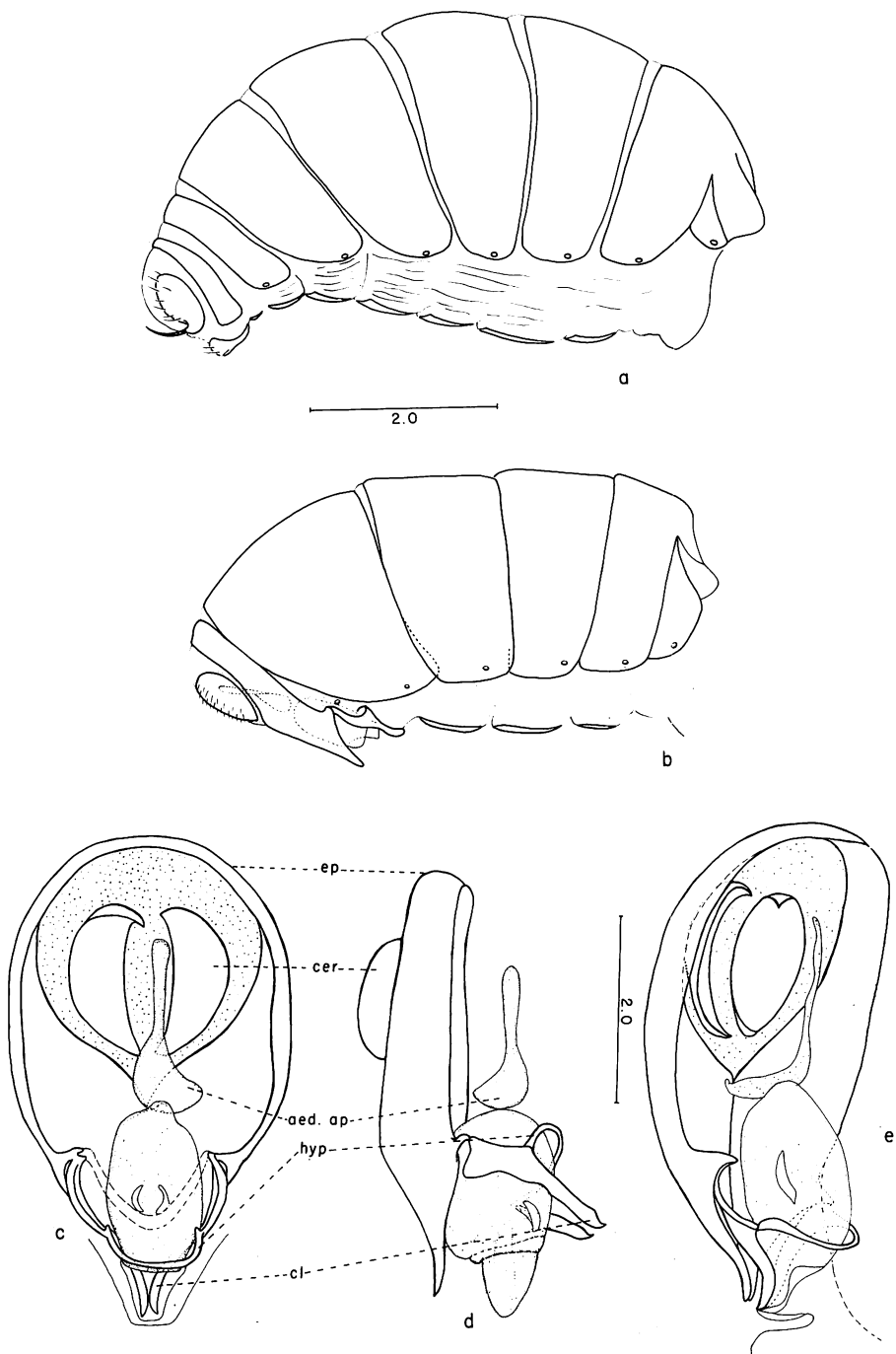


Figure 110—*Neoscatella* sp.: a, abdomen of female, lateral; b, abdomen of male, lateral; c, male genitalia, internal; d, male genitalia, lateral, e, male genitalia, partially lateral and partially internal.

Wirth (1948) revised the genera *Neoscatella* Malloch and *Apulvillus* Malloch and added to the Hawaiian ephydrid fauna the following new species: *Neoscatella cilipes*, *N. clavipes clavipes*, *N. clavipes tenda*, *N. fimbriata*, *N. kauaiensis*, *Apulvillus mauiensis*, and *A. williamsi*. One of Wirth's subspecies and one species are synonymized herein.

In 1952, Adachi reported seven immigrant species as new to the Hawaiian Islands, including *Placopsidella cynocephala* Kertész, which was erroneously recorded as a canaceid. The six other species reported were *Gymnopa grandis* Cresson, *G. tibialis* (Cresson), *Discocerina mera* (Cresson), *Clasiopella uncinata* Hendel, *Hostis guamensis* Cresson, and *Ceropsilopa coquilletti* Cresson. All of these species were collected on Oahu, except *Gymnopa tibialis* which was found on Molokai.

Hardy (1952) brought up to date the list of Ephydridae, adding to it *Ephydra riparia* Fallén, *Lytogaster gravida* (Loew), *Polytrichophora* sp., *Psilopa girschneri* von Roeder, and a genus, probably new, between *Limnellia* and *Scatella*. I have not seen any material of *Polytrichophora* sp. and cannot confirm the presence of this genus in the islands. The material upon which the report of the uncertain genus was based is described herein as comprising a new species of *Scatella*. The specimens reported as *Ephydra riparia* have been reidentified as *E. milbrae* Jones.

A first report of *Neoscatella sexnotata* (Cresson) outside the Hawaiian Islands was made by Joyce (1955) in which he recorded that species, as well as *Discocerina mera* (Cresson) from Wake Island.

In 1958, Sabrosky and Wirth reported a Formosan ephydrid, *Nannodastia horni* Hendel, from Oahu.

The latest report of an ephydrid new to Hawaii was made by Hardy in 1965, when he recorded a Formosan species, *Donaceus nigronotatus* Cresson, from Kauai and Oahu.

Most of the taxonomic literature to date has included fragmentary reports of new island records and descriptions of new species. With the exception of Wirth's revision of the *Neoscatella*, there have been no comprehensive studies on the Hawaiian Ephydridae. Williams' excellent studies on the biology of several species comprise the only presentation, to this time, of biological data of any scope.

The habitats of ephydrids are extremely varied and interesting. Although water is generally involved, the conditions of the medium in which ephydrids may breed sometimes border on the extremes of temperature, salt-saturation, and levels of pollution.

Aldrich (1912) reported *Ephydra gracilis* Packard and *E. hians* Say as breeding in the Great Salt Lake, Utah. The larvae of these species had been found living in pools where the water had practically evaporated, leaving behind salt crystals. According to Dahl (1959), both of these species are able to develop in water with 26% NaCl. Another interesting report concerns ephydrids breeding in hot springs, particularly in Iceland and Greenland. Böving (1925), Lindroth (1931), and Tuxen (1944) all give accounts of *Scatella thermarium* Col-

lin in hot springs. According to Lindroth (1931), the larvae of that species can survive in waters with temperatures as high as 55°C. Pools of crude oil provide an even stranger habitat for *Helaeomyia petrolei* (Coquillett), reported from California by Thorpe (1930). The larvae evidently feed on small insects which are accidentally trapped in the oil.

Some species of ephydriids bore or mine stems and leaves of aquatic plants. This particular habit is sometimes of concern to man, as in the larvae of at least three species of *Hydrellia* which have been reported attacking rice in the Philippines (Pathak, 1967, unpublished manuscript).

HAWAIIAN HABITATS INVESTIGATED AND THEIR EPHYDRIDAE FAUNA

“Habitat” is used here to mean, simply, the place where a species is generally found. The major habitats investigated and the species occupying them are discussed below, mention will be made only of species which were observed or collected in large numbers in each of the habitats mentioned. Further biological information regarding each species will be found under the sections on systematics of adults and immatures.

Maritime Habitats

Maritime habitats may be categorized for the purposes of this paper as intertidal and supratidal, as used by Odum (1959). Equivalent terms in the literature are the ‘littoral and supralittoral’ of Stephenson and Stephenson (1949) and of Moore (1958). Intertidal habitats include mouths of streams and seashores, while supratidal habitats include inland bodies of salt or brackish water.

INTERTIDAL HABITATS

On seashores, the immigrant species *Hecamede persimilis*, *Paratissa semilutea*, and *Placopsidella cynocephala* are commonly seen, particularly on dead seaweed and other debris washed onto the beach by waves. The first two species appear to be restricted to the seashore, while the latter may also be found in brackish water environments. The native species, *Neoscatella sexnotata*, is only occasionally found in seaweed; it is most abundant in rock and sand pools, and the muddy margins of mouths of streams.

SUPRATIDAL HABITATS

Several of the salt or brackish water ponds and canals on Oahu, Maui, and Hawaii were investigated to determine their ephydrid fauna; all of these bodies of water, except for Salt Lake on Oahu, have surface connections with the ocean. The margins of these ponds and canals are usually replete with organic detritus, algae, and various kinds of debris. Under these conditions, several

species of ephydrids were found to be very abundant. The areas investigated included Kaelepulu Pond (Enchanted Lake), Salt Lake, Ala Wai Canal, and Kuapa Pond on Oahu; Kanaha Pond on Maui; and Waiakea Pond on Hawaii. *N. sexnotata* was abundant in all except Waiakea Pond. *Scatella stagnalis* was abundant in Waiakea Pond, Kaelepulu Pond, Salt Lake, and Ala Wai Canal. *Mosillus tibialis* was plentiful in Kanaha Pond, and less so in Kaelepulu Pond. *Ephydra milbrae* occurred in large numbers both in Kanaha Pond and Ala Wai Canal; it was also found, although uncommonly, along the seashore in sand pools partially filled with rainwater. *Placopsidella cyncephala* was relatively abundant along the margins of Kaelepulu Pond, in addition to being abundant along the seashore.

Fresh-Water Habitats

Two major subdivisions of fresh-water habitats are recognized here; these are standing water and streams.

STANDING WATER

The fresh, standing water habitat is quite variable and includes a wide range of aquatic situations, from small puddles or temporary pools to ponds, reservoirs, and marshes. The water may be stagnant, muddy or clear; the margins may be grassy, muddy, or rocky; and the bottoms may be formed from soft mud, sand, gravel, or layered with decaying vegetation.

These types of habitats are occupied by both native and immigrant species. The most common of these are *N. hawaiiensis*, *N. bryani*, *N. oahuense*, *S. stagnalis*, and *Brachydeutera hebes*. *Psilopa olga* and *Clasiopella uncinata* were observed and collected in large numbers by Dr. D. E. Hardy along the margins of a pond at Makalawena, N. Kona, Hawaii (personal communication). *S. stagnalis* may be found in backyard fish ponds where there is vegetation growing along the margin of the pond. This species is believed to have immigrated into the islands only recently; yet I have found it already to be one of the most widespread species. *N. hawaiiensis*, *N. bryani*, *N. oahuense*, and *B. hebes* are particularly abundant in small puddles or pools in the forests. Pockets of small puddles or pools with a dense algal mat under a thin film of water are excellent habitats for *N. hawaiiensis* in particular. *B. hebes* is sometimes found in large numbers in many standing water situations, especially in the valleys and rain forests. Many adults, larvae, and pupae were observed in a pool with tea-colored water in Halawa Valley, Molokai. I have also observed *B. hebes* on several occasions breeding in temporary pools and discarded containers filled with rain water.

STREAM HABITATS

The majority of Hawaiian *Neoscatella* and *Apulvillus* are found in streams. Streams and their ephydrid fauna were investigated on five major islands

(Kauai, Oahu, Molokai, Maui, and Hawaii). Most of the streams sampled had temperatures around 20°C. and pH values between 6.2 and 6.4.

For the purpose of this study, I have categorized Hawaiian stream habitats according to light exposure and relative flow velocities as follows:

"Closed" stream: A closed-stream habitat is covered by a canopy of vegetation, as in many of the valleys and particularly in dense forests. Often, very little sunlight reaches that part of the stream and surrounding areas. A stream may be closed only while it flows through the forest, or it may be intermittently open and closed as it passes through pockets of dense vegetation.

"Open" stream: This stream habitat is exposed to direct sunlight. It is generally deep and wide so that the marginal vegetation does not converge overhead to form a canopy. It should be emphasized here that "openness" simply means the absence of overhanging vegetation over a stream or portion thereof; it does not mean that the whole length of the stream is exposed to direct sunlight. By the same token, a closed stream does not mean that it is covered by overhanging vegetation throughout its entire length.

Swift stream: In general, a swift-stream habitat is wide, deep, and has a water velocity of from 1.6 to 4.1 feet per second, with the lower reading taken along the stream margins. The bottoms and margins of swift-stream habitats are generally rocky, and, consequently, the water becomes very turbulent as it splashes against and flows around rocks and boulders in the stream. Waterfalls are considered here to fit into this category.

Slow stream: This stream habitat is usually narrow and shallow, with a water velocity of less than 1.5 feet per second, slower than the rate of flow of water along the margins of swift streams. Many streams in the forest which appear almost dry, with only a thin film of water trickling along, and the slow, shallow, gravel-bottom streams of the lowlands, fall into this category.

Based on the above categories, stream habitats may be designated for the purpose of associating them with their ephydrid fauna as (a) closed-swift, (b) closed-slow, (c) open-swift, or (d) open-slow. Any number of these habitats may be found in a single stream.

The number of species and individuals in streams depends largely on the kind of stream habitat and in what portion of the stream the sample was taken. In general, an open-swift habitat is richest in ephydrid fauna, both in number of species and in number of individuals. The ephydrids of open-swift habitats are sometimes so numerous that adult flies literally cover the exposed rocks in the stream and along its margins. The small sluggish larvae, which are generally imperceptible, can be easily spotted in large numbers, and the eggs can be seen as white patches on the rocks. Closed-swift habitats are next in terms of abundance of ephydrids, followed by open-slow, and then closed-slow.

In streams where the ephydrid populations are extremely large, such as in some open-swift habitats, the predominant species are found abundantly in the turbulent part of the stream and along the rocky margins. Species which occur only along the margins of swift streams, in the calmer areas, are the same

species which also occur in open-slow or in closed-slow stream habitats. Species occurring in the turbulent portion of swift streams may also be found in the flowing part of slow streams, but will not normally be found along the margins of these streams.

Commonly found in open-slow and closed-slow portions of streams are *N. hawaiiensis*, *N. bryani*, and *N. oahuense*; these same species may also be found along the calm margins of open-swift and closed-swift habitats. The small form of *N. oahuense* (with variable number of pale spots on the wings) generally occurs on rocks along the margins of closed-slow habitats.

In open-swift portions of streams, one finds most abundant *N. warreni*, *N. cilipes*, and *N. clavipes*. The first species occurs abundantly on all of the islands and is generally the dominant species wherever it is found. The species of *Apulvillus*, except for *A. femoralis* n. sp., *N. amnica* n. sp., *N. fluvialis* n. sp., and *N. kauaiensis* are also found in open-swift habitats. *Apulvillus mauiensis* was found extremely abundant at the base of a waterfall at the east branch of the Honokane Nui Stream in Hawaii, but was also found, although less abundantly, in open-swift habitats along the Hamakua Coast, Hawaii, usually in association with *N. clavipes* and *N. warreni*. On Kauai, *N. kauaiensis* occurs commonly in open-swift habitats with *N. cilipes* and *N. warreni*. On Maui, *A. mauiensis* and *N. amnica* n. sp. occur, usually few in number, along margins of open-slow stream habitats. The latter species, moreover, inhabits closed-slow and open-swift habitats on both Maui and Hawaii.

There is still much to be learned about the habitat associations, as well as the general biology of these adaptable flies. Little is known about the mating behavior and reproductive capacities of the Hawaiian Ephydridae. Moreover, scanty information is available on what ephydrids actually eat. In this connection, analysis of stomach contents should be informative and might reveal some habitat specializations based on food preferences. Regarding the chromosomes of these flies, some very superficial observations with a few species of native ephydrids were made during this study with the help of Dr. Kenneth Kaneshiro, University of Hawaii, who has had experience in analyzing Drosophilidae chromosomes. Unfortunately, the metaphase chromosomes from adult testes were too small for detailed analysis in the few species examined, but certainly much more research needs to be carried out before any definite statement on ephydrid chromosomes can be made. Present knowledge of parasites of this group is also inadequate. Two species of hymenopterous parasites have been found to attack *Neoscatella* and *Ephydra* in Hawaii. The Pteromalidae, *Urolepsis rufipes* (Ashmead), has been collected from pupae of *Ephydra milbrae* and *Neoscatella sexnotata* in low-land brackish water situations, while one species of Cynipidae (prob. *Kleidostoma* sp.) has been found attacking *Neoscatella* pupae in high-land streams. Otherwise, little is known about this area of Hawaiian Ephydridae biology.

The systematic arrangement of the Ephydridae subfamilies and genera treated in the present study follows the system established by E. T. Cresson, Jr., based on his long years of investigations of the family as a whole (Cresson,

1942-1949). I have, however, adopted the subfamily Parydrinae as used by Wirth and Stone (1956) and Wirth (1965, 1968) in place of Napaeinae of Cresson.

KEY TO THE GENERA OF EPHYDRIDAE IN HAWAII

1. Median facial area setulose, the setae sometimes small, the facial series of bristles converging at upper part of face; mouth opening large, its margin usually lined with long bristles. (Subfamily Ephydrinae) 21
- Median facial area bare. Not conforming to the combination of characters above. 2
- 2(1). Head with fronto-orbitals latero-clinate, curving over the eyes, sometimes small, rarely absent. 2nd antennal segment without spinous bristles on upper surface. (Subfamily Parydrinae) 19
- Head with fronto-orbitals reclinate or proclinate, rarely absent. 2nd antennal segment on upper surface with one or more spinous bristles. 3
- 3(2). Mesonotum without discal seriate macrochaetae, at most with a pair of either dorsocentral or acrostichal prescutellars and a pair of posterior intralalars. (Subfamily Psilopinae) 4
- Mesonotum with well-developed discal seriate macrochaetae; at least two pairs of strong dorsocentrals present. (Subfamily Notiphilinae) 17
- 4(3). Setation usually very much reduced. Postbucca bare, extensive, with posterior margin sharp and usually reflexed or marginated; facial area usually sculptured and the facials situated in pitted or rugulous depressions. Antennae always simple with arista sometimes bare. 5
- Setation usually well developed (except in *Discomyza* which has frons and face sculptured). If postbucca is extensive, it is setulose and posterior margin is not reflexed. Facial area not noticeably sculptured (except in *Discomyza*); facials may be situated on papillae but not in depressions. 7
- 5(4). Surface of body subopaque, more or less pruinose. Face with vertically elongated, bare tubercle; postbucca not marginated. **Placopsidella** Kertész.

- Surface of body shining, sparsely pollinose. Face tubercle round or subconical; postbucca margined. 6
- 6(5). Face including parafacies densely pitted, the median tubercle not distinct. **Chlorichaeta** Becker.
Face irregularly rugulose; face tubercle well developed and distinct. **Mosillus** Latreille.
- 7(4). Posterior notopleural distinctly removed dorsad from the notopleural suture, sometimes well into sutural angle (*Atissa antennalis* somewhat aberrant). Mostly opaque pruinose species. 8
Posterior notopleural at or near notopleural suture, horizontally aligned with anterior notopleural. . . . 10
- 8(7). Face with median shiny tubercle; mesofrontal triangle setulose. Scutellum with more than four marginal bristles. **Hecamede** Haliday.
Face without median tubercle; mesofrons bare. Scutellum with four marginal bristles. 9
- 9(8). Fronto-orbitals caudad of line of ocellars. Wing with fore and hind crossveins absent; fourth vein extremely weak, especially apically.
. **Nannodastia** Hendel.
Fronto-orbitals cephalad of line of ocellars. Wing with crossveins present; fourth vein dark and heavy. **Atissa** Haliday.
- 10(7). Ocellars situated cephalad of line of anterior ocellus. Mostly opaque pruinose species. 11
Ocellars situated caudad of anterior ocellus, sometimes between posterior ocelli. Mostly shining to polished species. 13
- 11(10). Notopleura setulose. Head with parafacies relatively narrow; facial series of three or more primaries. Shining dark species. **Discocerina** Macquart.
Notopleura not setulose, but two notopleural bristles present. 12
- 12(11). Frons with one pair of interfrontals cephalad of anterior ocellars; two pairs of proclinate and one pair of reclinate fronto-orbitals.
. **Paratissa** Coquillett.
Frons without a pair of bristles cephalad of anterior ocellars; one pair of proclinate and one pair of reclinate fronto-orbitals. **Hostis** Cresson.

- 13(10). Head with only the reclinate fronto-orbitals present.
 **Atissa** Haliday.
 Head with proclinate and reclinate fronto-orbitals
 present. 14
- 14(13). Face and frons distinctly sculptured; three or more
 facials present, well removed from parafacies.
 Setation generally weakly developed. Mesonotal
 setulae not seriated. **Discomyza** Meigen.
 Face and frons at most weakly sculptured; rarely
 two subequal facials present which are usually
 near parafacies. Setation generally well devel-
 oped. Mesonotal setulae usually distinctly seri-
 ated. 15
- 15(14). First antennal segment only slightly exerted; second
 segment with stout spines. 16
 First antennal segment elongate; second segment
 without stout spines, but may have curved hair-
 like bristles. Face convex or gibbose, with retreat-
 ing epistoma. **Ceropsilopa** Cresson.
- 16(15). Face convex or gibbose medially. Anterior ocellars
 situated directly cephalad of posterior ocelli.
 **Psilopa** Fallén.
 Face transversely prominent medially. Anterior
 ocellars situated slightly laterad of post ocelli.
 **Clasiopella** Fallén.
- 17(3). Ocellar bristles weak, postocellars strong.
 **Hydrellia** Robineau-Desvoidy.
 Ocellar bristles strong, postocellars always weak. 18
- 18(17). Wings with costa extending only to third vein. Mid-
 dle tibia dorsally with at least three strong setae. .
 **Notiphila** Fallén.
 Wings with costa extending to fourth vein. Middle
 tibia without distinct strong setae dorsally. Poste-
 rior notopleurals well removed dorsad from noto-
 pleural suture. Wings brown with numerous pale
 spots. **Donaceus** Cresson.
- 19(2). Mouth opening large and gaping; antennal arista
 with long dorsal rays; fronto-orbitals well devel-
 oped. Wings with costa extending to third vein. .
 **Brachydeutera** Loew.
 Mouth opening small; antennal arista bare or mi-
 nutely pubescent; fronto-orbitals greatly reduced.
 Wings with costa extending to fourth vein. 20

- 20(19). Abdomen greatly convexed above and concave below; fourth tergum elongated, longer than fifth.
 **Lytogaster** Becker.
 Abdomen not convexed above; fourth tergum never longer than fifth. **Hyadina** Haliday.
- 21(1). Head with three pairs of strong fronto-orbitals. . . .
 **Ephydra** Fallén.
 Head with only two pairs of strong fronto-orbitals. . . . 22
- 22(21). Tarsal claws relatively long. Median facial area and oral margin with very weak setulae. Bristles and setulae on head and thorax generally weakly developed; acrostichals and presutural dorsocentrals, if present, weak. **Apulvillus** Malloch.
 Tarsal claws normal. Bristles and setulae on head and thorax relatively well developed; acrostichals and presutural dorsocentrals strong. 23
- 23(22). Mesonotum with presutural dorsocentrals absent; one pair of strong acrostichals at or near the suture. **Scatella** Robineau-Desvoidy.
 Mesonotum with presutural dorsocentrals present; one or two pairs of strong acrostichals present. . .
 **Neoscatella** Malloch.

Genus **CHLORICHAETA** Becker

Chlorichaeta Becker, 1923, Denkschr. Akad. Wissen. Wien. 98:73. Type-species, *tuberculosa* Becker, by original designation.

This genus is characterized as follows: facial area including the parafacies pitted and the pits lined with silver; tubercle on median facial area small; frons polished and smooth, the ocellar tubercle hardly elevated; vertex and posterior margin of gena sharp, the gena bare, glossy black, and large (about as high as height of eye); clypeus exposed, tongue-like, about one antennal length from the epistoma; fore femora with a series of post-flexor spines at apical half, one long spine at middle of femora and successively smaller ones to apices; and bristles greatly reduced.

Members of the genus, according to Cresson (1946), occur about sores on various mammals; some have been found on coccids on the trunk of the China-tree in Angola, Africa. *C. tuberculosa* has been reported on cattle sores, while *C. albipennis* has been recorded from camel sores. The latter species, which is present in the islands, has recently been collected from eye sores on a dog on the island of Hawaii.

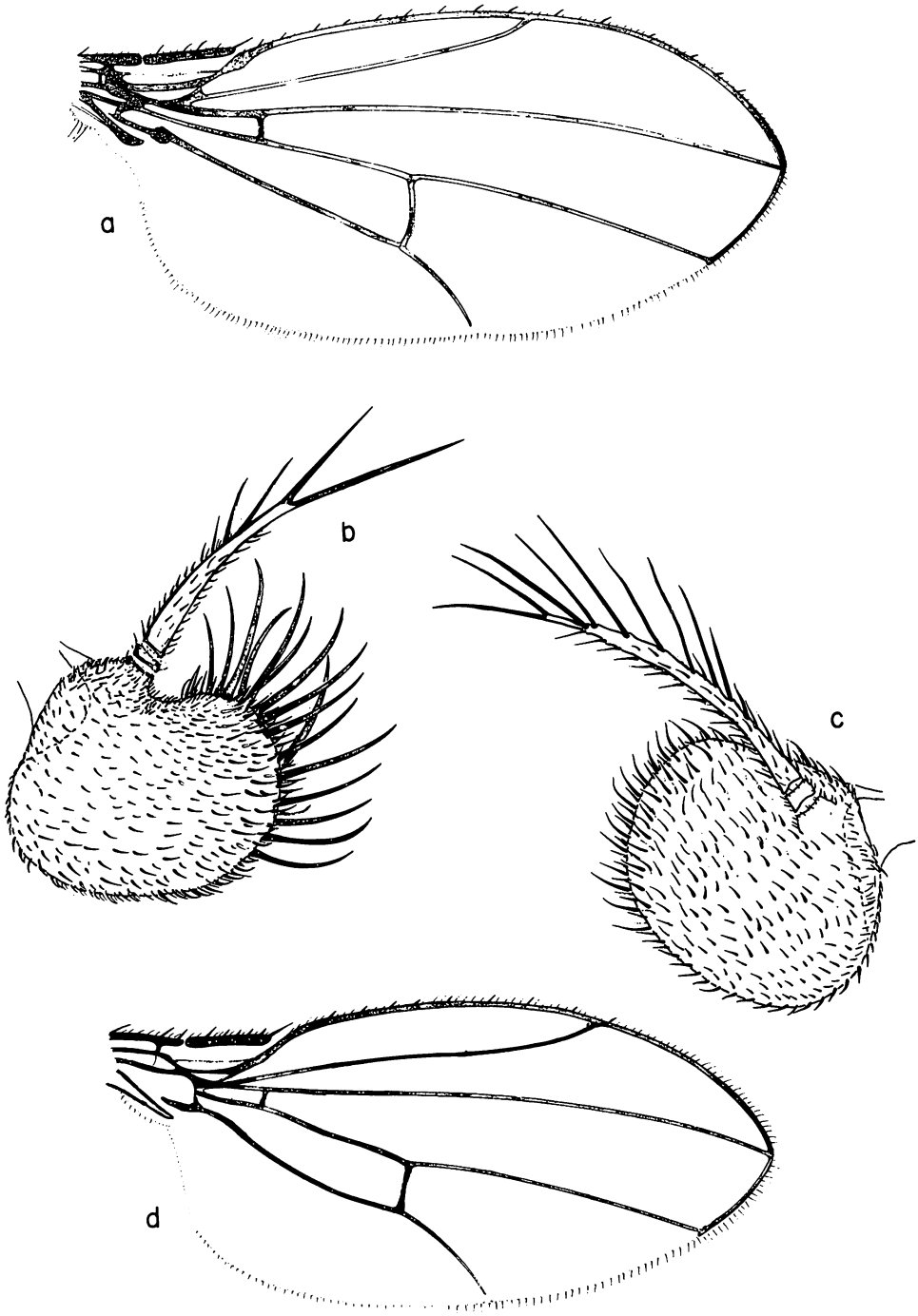


Figure 111—*Atissa antennalis* Aldrich: a, wing; b, antenna. *A. oahuensis* Cresson: c, antenna; d, wing.

***Chlorichaeta albipennis* (Loew) (fig. 119a)**

Gymnopa albipennis Loew, 1848, Stett. ent. Zeit. 9:14. Type in Naturhistorisches Museum, Wien.

Mosillus albipennis, Schiner, 1864, Faun. Austr. 2:235.

Chlorichaeta albipennis, Cresson, 1925, Trans. Amer. Ent. Soc. 51:235.

Hawaii, Kauai, Oahu. First captured in Honolulu, Oahu (November 1951, D. E. Hardy) and determined by Dr. W. W. Wirth in 1968, but not reported previously in the literature. This report, therefore, constitutes a new state record for both the genus and the species.

Immigrant. Originally described from southern Europe and occurring in countries bordering the Mediterranean.

Shiny black species with milky white wings. Head bristles reduced, with minute inner and outer verticals and ocellars; ocellars placed laterad and at the level of the anterior ocellus. Frons shiny black, about as wide as long. Ocellar tubercle not raised, but ocelli individually raised. Antennae touching and lying flat in the antennal groove; first segment obstructed from view, second bearing a fine bristle dorsally near base and about as long as width of the third; third segment about three-fourths as wide as long; arista bare. Eyes about one-half as high as the head, anterior margin with thin line of silver. Gena bare, polished black, and large. Face, including the mesal portion of parafacies, with silver-lined pits; median tubercle not very distinct. Clypeus exposed tongue-like, this portion about one antennal length. Thorax shiny black with reduced chaetotaxy. Anterior notopleural absent, posterior notopleural situated close to the posterior angle of notopleura. Two mesopleurals and one sternopleural present. Scutellum rectangular, slightly wider than long, shallowly rugose above; four scutellars, each borne on a tubercle, and a series of setulae along the lateral margin. Fore femora with a row of post-flexor spines at apical half, the spine at middle of femora longest; mid- and hind-tarsi reddish brown, darker apically. Wings milky white; costa extending to fourth vein, short spine-like bristles extending to middle of third costal sector; second sector less than twice the third sector; alula large. Halteres reddish brown like the middle and hind tarsi. Abdomen minutely punctured above, making abdomen appear somewhat opaque, otherwise shiny black. Fifth tergum with two circular, hairy depressions near middle. Female ventral receptacles as in figure 119a.

Length: body, 1.9 mm.–2.4 mm.; wings, 1.4–2.0 mm.

The immature forms of this species are not known, and adult habits are but little known. Evidence seems to indicate that adults are attracted to sores on mammals. In Africa, Cresson (1946) reported specimens of this species collected on camel sores. In Hawaii, Dr. D. E. Hardy, University of Hawaii, collected a series of specimens from a dog with infected eyes. Dr. Hardy observed large numbers of these flies hovering and flying about the dog's eyes, much in the same manner as the eye gnat, *Hipellates* (Chloropidae).

This species may also be found on the seashore, especially on the sand. In this environment, it is extremely difficult to see. The fly is small, and its shiny

black head and thorax reflect light in such a way as to make it appear like a grain of sand. The milky white wings lying flat over the abdomen at rest also blend in very well with the white sand background. Moreover, when disturbed, *C. albipennis* flies very close to the sand, making it virtually impossible to capture by sweeping without filling the net with sand.

Genus **MOSILLUS** Latreille

Mosillus Latreille, 1804, Tabl. Meth. Ins., p. 196. Type-species, *arcuatus* Latreille, subsequent designation (Latreille, 1805), = *subsultans* (Fabr.).

Gymnopa Fallén, 1820, Oscinides Sveciae, Lundae, p. 10. Type-species, *aenea* Fallén, by monotypy, = *subsultans* (Fabricius).

Members of this genus have weak or underdeveloped macrochaetae; face wrinkled medially and with a round shining tubercle; arista bare or pubescent; mesonotum and scutellum finely granulose, giving a subopaque appearance; body setulae numerous; and alula of the wings large.

Two species, both introduced, are found in Hawaii.

KEY TO SPECIES OF MOSILLUS IN HAWAII

1. Gena, pleuron, and front femur opaque brown.
Front femur without post-flexor setae. **grandis** (Cresson).
Gena, pleuron, and front femur polished black.
Front femur bearing short, but strong, post-flexor
setae. **tibialis** Cresson.

Mosillus grandis (Cresson) (fig. 119b)

Gymnopa grandis Cresson, 1925, Trans. Am. Ent. Soc. 51:232. Holotype female in Academy of Natural Sciences of Philadelphia.

Oahu, Midway I., and Kahoolawe I. First reported on Oahu (taken along beaches on *Scaevola*) by Adachi (1952). Specimens from Midway I. and Kahoolawe I. constitute new island records.

Immigrant. Described from Formosa.

M. grandis can be distinguished easily from *M. tibialis* by the opaque brown thorax and the absence of strong post-flexor setae on the fore femur. In general appearance, such as color and size, it resembles *Placopsidella cynocephala* Kertész more than it does *M. tibialis*. However, *P. cynocephala* has the median facial tubercle vertically elongated and the halteres yellow; the facial tubercle is round and dark and the halteres brown to black in *M. grandis*.

Dark brown to black, somewhat shiny species, particularly on the abdomen. Antennae light brown, rather pale on ventral portion of third segment. Wing veins and tarsi (except the apical tarsomeres which are dark brown to black) yellowish; halteres black. Face silvery or grayish with the following areas polished black: median tubercle and a small area above it; a strip at each side

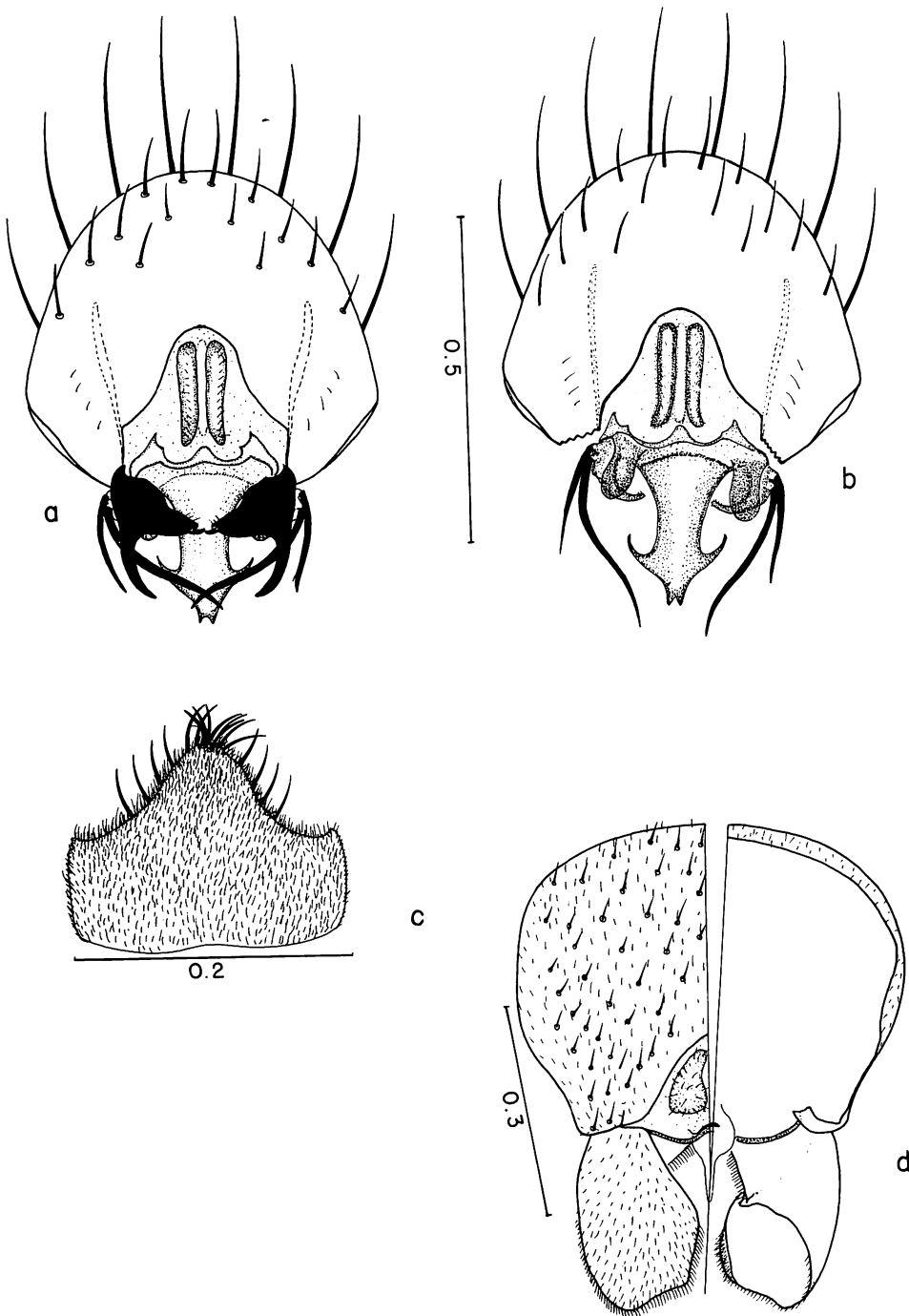


Figure 112—*Clasiopella uncinata* Hendel: a, male genitalia, external; b, male genitalia, external, with claspers removed; c, female 8th sternum. *Discomyza maculipennis* (Wiedemann): d, male genitalia, external (left side) and internal (right side).

of the tubercle to the oral margin; bases of facial hairs; and the parafacial ridge from the ptilinal area to the oral margin. Abdomen generally somewhat shining black, the apical margins of terga grayish. Female ventral receptacle (fig. 119b) similar to same of *P. cynocephala* (fig. 119d).

Mosillus tibialis Cresson (fig. 119c)

Mosillus tibialis Cresson, 1961, Ent. News. 27:149.

Maui, Molokai, and Oahu. First reported from the island of Molokai by Adachi (1952). Additional specimens have since been collected from Oahu and Maui, and these constitute new island records.

Immigrant. Described from New Jersey.

Holotype male in Academy of Natural Sciences of Philadelphia.

Shiny black species with parafacies, antennal fovea, and lateroventral portion of face silvery. Mesofrons hairy and minutely punctured. Lateral margin of frons and genae polished black. Fore femora black; apical one-third ventrally indented and bearing nine short but strong post-flexor setae, the one closest to the middle of the femur about twice as long as the others. Tibiae and tarsi (except apical tarsomeres which are brown) yellow, the outer surfaces on the tibiae silvery. Wings milky white. Female ventral receptacle as in figure 119c.

While large numbers of adults were collected from the margins of Kanaha Pond on Maui and Enchanted Lake, Oahu, no immatures were found. In both areas, the adults were congregating in muddy areas around the margins, and the water was polluted. On Maui, the pond water was turbid, and on Oahu, large amounts of debris, particularly partially decayed paper, was observed in the water.

Genus **PLACOPSIDELLA** Kertész

Placopsidella Kertész, 1901, Termézet. Füzetek. 24:424. Type-species, *cynocephala* Kertész, by monotypy.

Oscinomima Enderlein, 1912, Stettin. ent. Ztg. 83:163. Type-species, *signatella* Enderlein, by original designation.

Enchastes Lamb, 1912, Trans. Linn. Soc. Lond. (2), Zool. 15:319. Type-species, *scotti* Lamb, by original designation.

Similar to *Mosillus*, from which it may be distinguished by the vertically elongate facial tubercle which is rounded in *Mosillus*.

Ocellars situated cephalad of anterior ocellars. Face pollinose gray, except the facial tubercle which is shiny black, and concave below the antennae. Facials short, borne on tubercle, and directed inward.

One species of this genus is present in Hawaii.

Placopsidella cynocephala Kertész (fig. 119d)

Placopsidella cynocephala Kertész, 1901, Termézet. Füzetek. 24:425. Type in Hungarian National Museum.

Oahu, Hawaii, and Kauai. The latter two are new island records.

A complete list of synonymies is given by Cresson (1925).

Immigrant. Described from Seleu, New Guinea. The present distribution includes Java, Solomon Is., "Simalu Is." (probably Simalur Is. [= Simeuluë], off N.W. coast of Sumatra), Seychelles Is., Guam, Canton I., and the Hawaiian Is.

This species was first recorded from Oahu by Adachi (1952) as belonging to the Canaceidae. I have seen correspondence, written to Dr. D. E. Hardy from Dr. W. W. Wirth, in which was included a list of Ephydridae and Canaceidae determined by Dr. Wirth. In this list, *P. cynocephala* was correctly placed under the Ephydridae. The error of family placement probably occurred when the list was retyped to report the species at the Hawaiian Entomological Society meeting. This species was also listed by Hardy (1952) incorrectly under the Canaceidae.

Similar to *Mosillus grandis* Cresson, the details of which are mentioned under that species.

Opaque grayish brown species with three fairly distinct brown vittae on the mesonotum. Antennae reddish brown with bare arista. Clypeus exposed tongue-like, about one-half as wide as long, shiny at apical margin. Mesonotal bristles reduced or absent, except for a pair of short prescutellars about as far apart as the width of the scutellum. Scutellum with disc setulose, with two apicals and several recumbent marginals. Notopleura setulose, with only the posterior notopleurals distinct. Halteres and tarsi, except apical tarsomeres of latter, yellowish or reddish brown. Female ventral receptacle as in figure 119d.

This species is common in seaweed and debris on beaches. Adults have been observed in large numbers emerging from piles of seaweed in Kailua and Waimanalo Beaches. On the island of Hawaii, sugar cane debris, washed onto the beach by waves, provides a favorable environment for this species.

For further details on larvae and pupae of this species, refer to the section on immatures, pp. 331-351.

Genus **ATISSA** Haliday

Atissa Haliday, in Curtis, 1837, A Guide to an Arrangement of British Insects, Ed. 2:281. Type-species, *Ephydra pygmaea* Haliday, by monotypy.

Parephydra Coquillett, 1902, J. N.Y. ent. Soc. 10:183. Type-species, *humilis* Coquillett, by original designation, = *pygmaea* (Haliday).

The members of this genus are among the smallest in the family. Two species occur in Hawaii, both of which are found along the seashore. Some specimens have been taken at light traps, others by sweeping along the seashore and along margins of saline ponds. The immature forms are unknown.

This genus is characterized by having the posterior notopleurals generally well removed dorsad from the notopleural suture; the arisal hairs curved toward the apex, frontals placed cephalad of the line of the ocellar bristles, the latter being caudad of the anterior ocellus; and the face most prominent near the epistoma.

KEY TO SPECIES OF ATISSA IN HAWAII

1. Antenna with third segment bearing long setae at the apical margin; arista with three to four short dorsal rays. Posterior notopleurals not distinctly more removed from notopleural suture than the anterior ones. **antennalis** Aldrich.
 Antenna without long setae at apex of third segment; arista with six to eight dorsal rays. Posterior notopleurals distinctly more removed dorsad from notopleural suture than the anterior ones. **oahuensis** Cresson.

Atissa antennalis Aldrich (figs. 111a-b, 119e)

Atissa antennalis Aldrich, 1931, Proc. Haw. ent. Soc. 7:395.

Endemic. Necker I. (type locality), Nihoa I., Oahu, Maui, Kauai, and Hawaii. The latter four are new island records.

Holotype female in U.S. National Museum, Cat. No. 41630; one paratype in B. P. Bishop Museum, Honolulu.

A. antennalis is a somewhat aberrant member of the genus, as Cresson states (1948:24), in that the posterior notopleurals are not noticeably removed from the notopleural suture and only slightly dorsad of the horizontal alignment of the anterior notopleurals.

Small species (0.9-1.4 mm.), ranging from dark brown to black in color. *Head*: Eyes pilose. Face, genae, and posterior region of head dusted gray. Antennae close together, almost touching; second segment of antenna (fig. 111b) as long as, or longer than, width of third, the latter kidney-shaped and slightly wider than long and the apical margin bearing five to ten conspicuously long hairs; arista with three to four short hairs above. Face prominent near epistoma; four facials present, the uppermost at about the lower one-third of face. Proclinate orbitals greatly reduced, closer to eye margin than the reclinate orbitals. *Thorax*: Posterior notopleurals in line with, or slightly dorsad of, line of anterior notopleurals. Mesonotal setulae in four to six rows between the intra-alars. Four marginal scutellars, a pair of fine hair-like setulae may be present one-half way between the basals and the apicals, the latter strongly cruciate; disc of scutellum with one to two pairs of setulae situated at the middle. Wings as in figure 111a; halteres brown. *Abdomen*: Female ventral receptacle as in figure 119e.

This species is rarely collected. Because of their small size, a very fine mesh net is necessary to capture these flies. To date, *A. antennalis* has been collected only along the seashore. The larvae and adults are probably scavengers feeding on decaying organic matter along the beach.

Atissa oahuensis Cresson (figs. 111c-d, 119f)

Atissa oahuensis Cresson, 1948, Trans. Am. ent. Soc. 74:24. Holotype male in the U.S. National Museum.

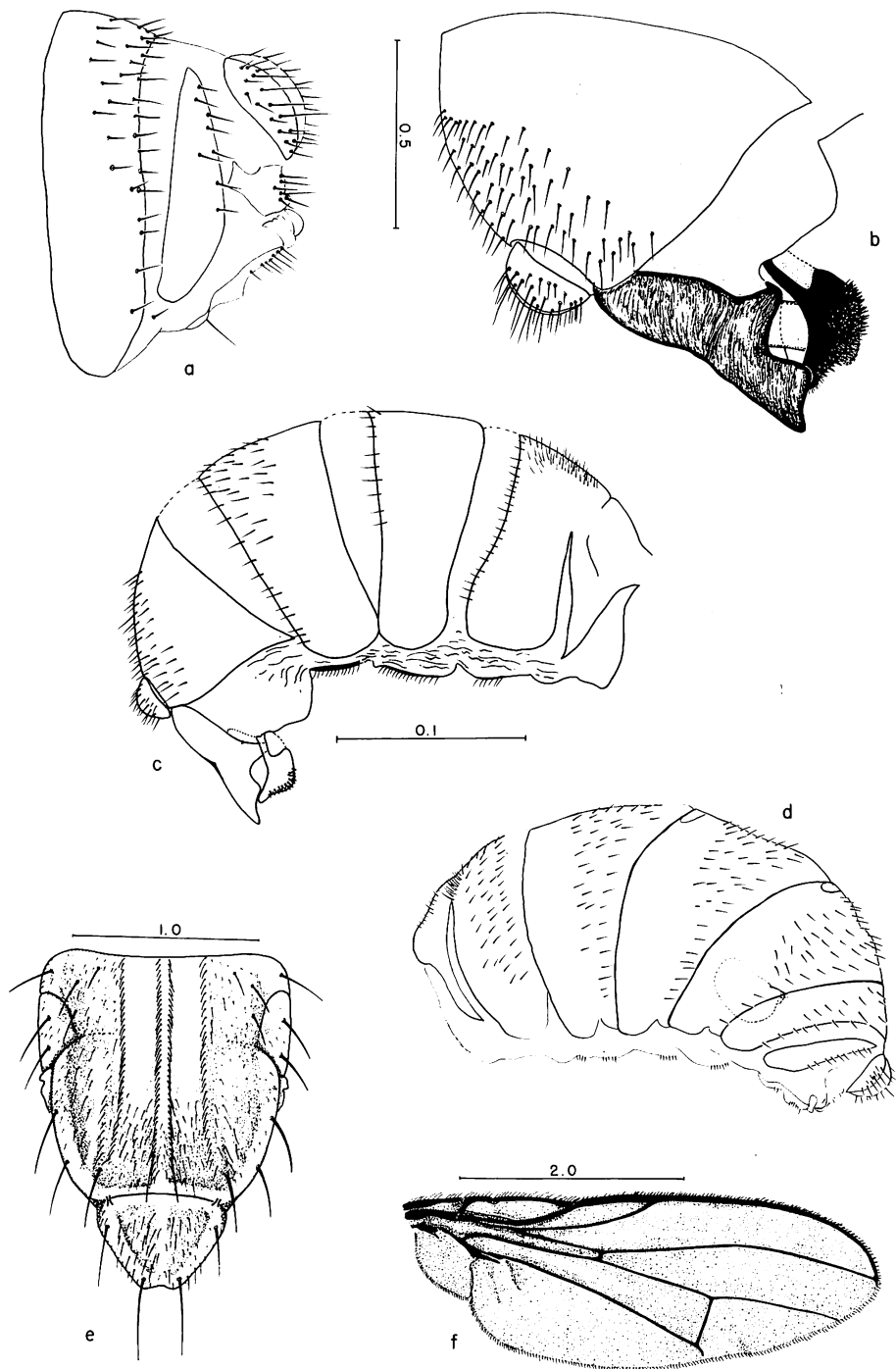


Figure 113—*Brachydeutera hebes* Cresson: a, apex of female abdomen, lateral; b, apex of male abdomen, lateral; c, male abdomen, lateral; d, female abdomen, lateral; e, thorax, dorsal; f, wing.

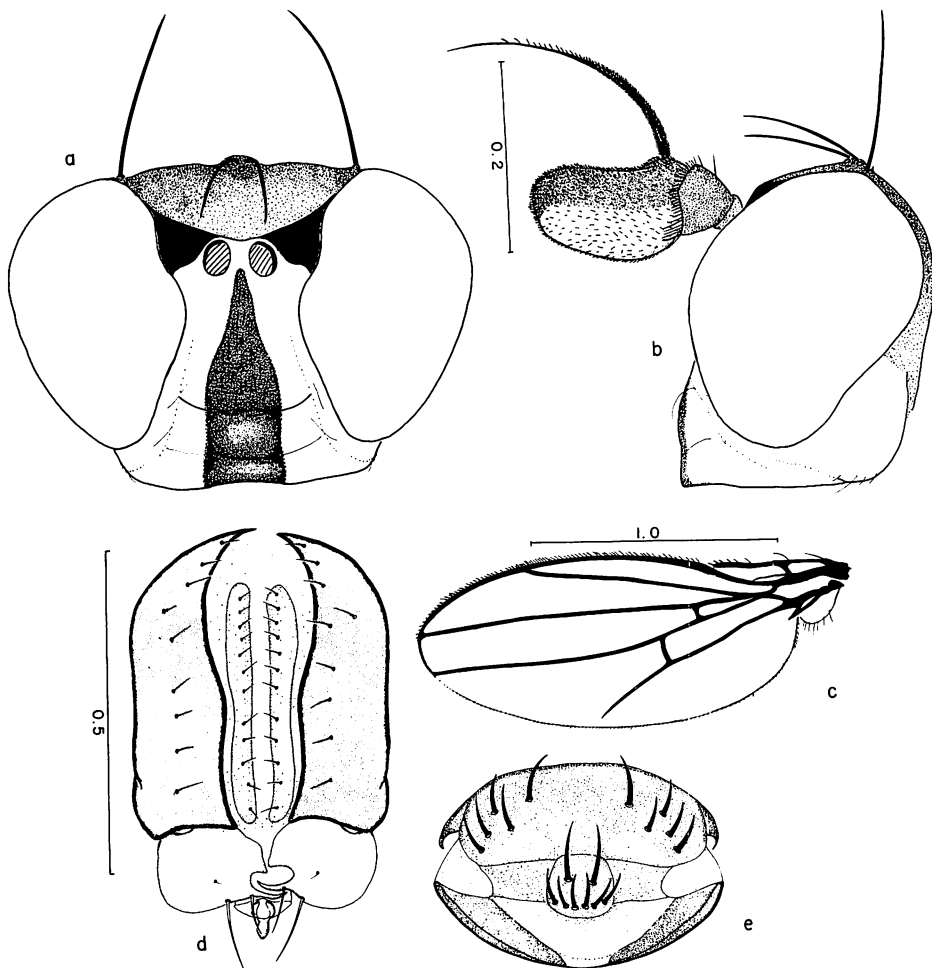


Figure 114—*Hyadina vittifacies* Tenorio, n. sp.: a, head, anterior, with antennae removed; b, head, lateral; c, wing. *Donaceus nigronotatus* Cresson: d, male genitalia, external; e, female 8th sternum (bristles directed posteriorly).

Endemic. Oahu (type locality: Tuna Packer's Pond, Kaneghei). "Kaneghei" in the type locality is a misspelling and should be Kaneohe.

This species may be distinguished as follows: antennae yellowish brown (fig. 111c); third segment oval with short pubescence; arista with six to eight dorsal rays (three to five in *antennalis*). Posterior notopleurals distinctly removed dorsad from the notopleural suture and clearly dorsad to the horizontal alignment of the anterior notopleurals. Mesonotal setulae in four to six irregular rows between the intra-alars; a pair of post-sutural acrostichals present in line with and as strong as the intra-alars. The combination of mesonotal setulae and pollen sometimes gives a coppery iridescent appearance to the mesonotum. Halteres white. Wings brown, broad, and pointed at apex of $R_4 + 5$; second

costal sector about one-third again as long as third (fig. 111d). Female ventral receptacle as in figure 119f.

This species is very similar to *A. antennalis* in size, but somewhat lighter in color. *A. oahuensis* has the posterior notopleurals distinctly more removed dorsad from the notopleural suture than the anterior notopleurals; in *antennalis*, the anterior and posterior notopleurals are about the same distance from the suture.

Like *antennalis*, *oahuensis* occupies the seashore habitat, including saline ponds close to the ocean. In some cases, it occurs farther inland, as some specimens have been taken in light traps away from the shoreline. Because of their small size, too often these flies are missed in a sweep net whose contents are just superficially examined. I have never collected any adults and know nothing of their habits.

Genus **HECAMEDE** Haliday

Hecamede Haliday, 1839, Ann. Mag. nat. Hist. 3:224. Type-species, *Notiphila albicans* Meigen, by monotypy.

Members of this genus are relatively small and are generally found in costal regions. Cresson (1925) pointed out the similarities of species in this genus to those under Discocerini, especially with regard to arista pectination and the chaetotaxy of the frons. However, the facial characters and the sharp post-buccal margin clearly place this genus under Gymnolini.

Face with median shiny tubercle, mesofrontal triangle setulose, genae broad and setulose, and the scutellum with three pairs of marginal bristles.

One species of *Hecamede* occurs in Hawaii.

Hecamede persimilis Hendel (fig. 120a)

Hecamede persimilis Hendel, 1913, Supplta. ent. 2:99. Three syntypes in Deutsches Entomologisches Institut.

Hecamede nivea de Meijere, 1915, Tijdschr. Ent. 58(Suppl.):61.

Hecamede femoralis Malloch, 1930, Rec. Canterb. Mus. 3:245.

Presently found on almost all the major islands, recorded here for the first time from Maui, Molokai, Kauai, and Kure I. Most likely this species is also present on Lanai, as it is very abundant on beaches. It has previously been reported from French Frigate Shoal, Lisianski I., and Pearl and Hermes Atoll by Beardsley (1966).

Immigrant. Described from Formosa and first reported from Kahoolawe I. by Bryan (1933) as *Hecamede albicans* (Meigen), a European species. The female specimens collected from Kahoolawe is in the U.S. National Museum, and was determined as *H. persimilis* by Wirth. This finding was subsequently reported by Adachi (1952).

Small species, generally light gray, but coppery-brown on dorsum; wings rather milky; halteres, tibiae, and tarsi, except for apex of latter, yellow. Gena and face whitish gray; shiny spots on median facial tubercle and at bases of the

facials approximately equal in size, the spots at bases of facials slightly smaller. Frons reddish brown outside the frontal triangle, particularly anteriorly; two pairs of setae cephalad of the anterior ocellus; ocellars situated between the posterior ocelli. Female ventral receptacle as in figure 120a.

H. persimilis is very common along the seashore, especially on sandy beaches with seaweed washed by waves. I have observed large numbers of adults on rotting fish and crabs on the sand. Larvae and pupae may be collected from moist seaweed and easily reared in this medium to adulthood in the laboratory.

Larvae and pupae of this species are described in the section on immatures, pp. 331-351.

Genus **NANNODASTIA** Hendel

Nannodastia Hendel, 1930, Konowia. 9:68. Type-species, *horni* Hendel, by monotypy.

This monotypic genus was proposed to include a species from Formosa.

The genus is best recognized by its unusual wing venation, the shape of the face, and the absence of strong prescutellar acrostichals. The most characteristic features of the wing are the lack of crossveins and the extremely weak fourth vein. The eyes appear kidney-shaped, as viewed from the front, and the face is slightly produced near the epistomal margin.

Only a single species is known in this genus and this is present in Hawaii.

Nannodastia horni Hendel

Nannodastia horni Hendel, 1930, Konowia. 9:70. Two syntypes in the Deutsches Entomologisches Institut.

Oahu. First reported by Sabrosky and Wirth (1958).

Immigrant. Described from Formosa.

Sabrosky and Wirth (1958) reviewed this species.

N. horni is easily recognized by its unique wing venation and minute size (length, 0.66 mm.). The following excerpt is taken from the redescription by Sabrosky and Wirth (p. 109): "Particular attention is called to . . . the two costal breaks, abbreviated subcosta, union of second basal and discal cells, absence of fore and hind crossveins, and absence of alulae. The wing membrane is thickly covered with microtrichia. The second vein ends about mid-way on the anterior margin of the wing. The third and fifth veins are dark and heavy, whereas the second vein is somewhat weaker and the fourth vein exceptionally slender and weak."

Hendel (1930) illustrated the wing and head.

Genus **DISCOCERINA** Macquart

Discocerina Macquart, 1835, Hist. Nat. Ins. Dipt. 2:527. Type-species, *Notiphila obscurella* (Fallén), = *Notiphila pusilla* Meigen (Coquillett, 1910:534).

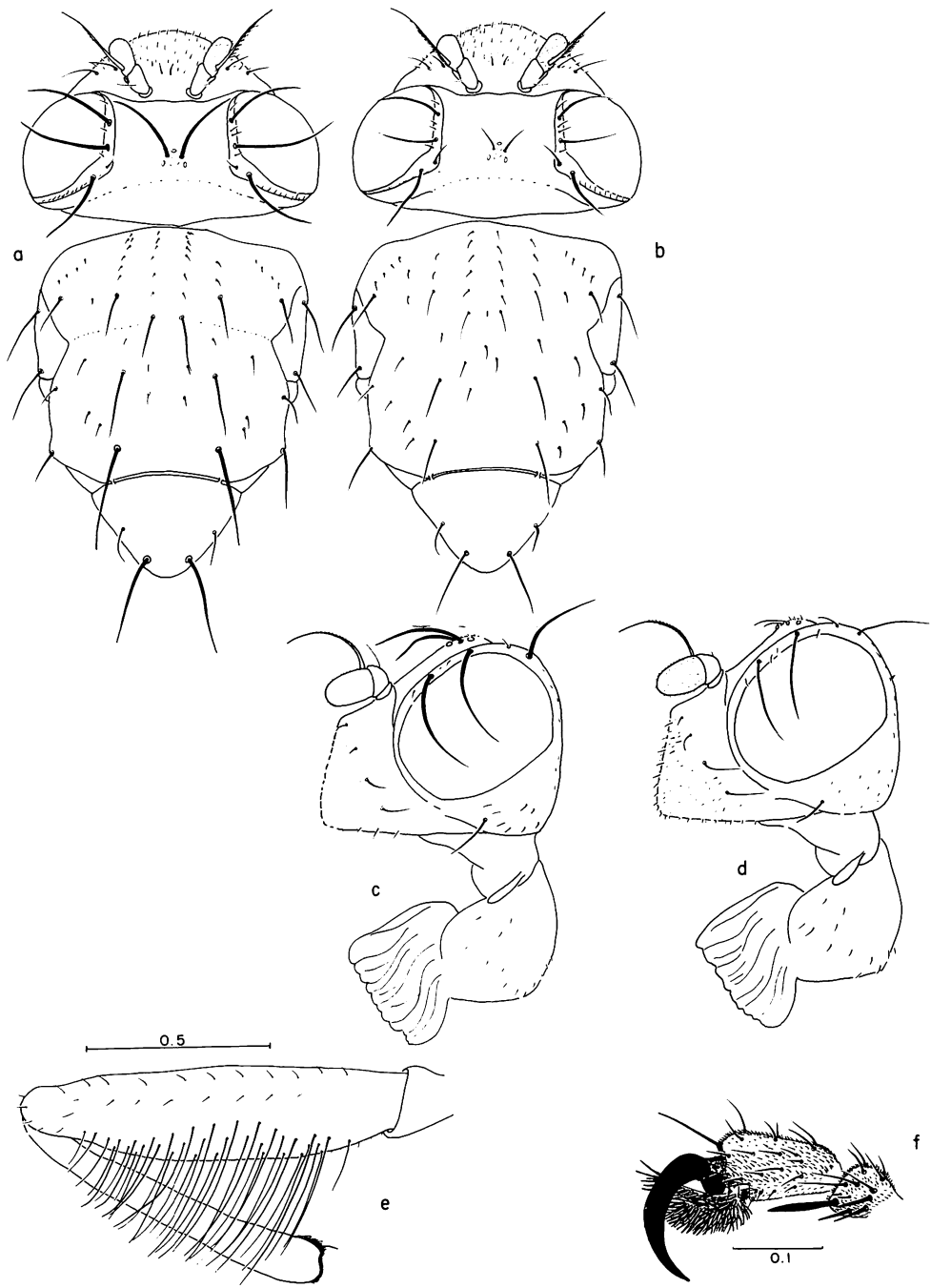


Figure 115—*Apulvillus mauiensis* Wirth: a, head and thorax, dorsal; c, head, lateral. *A. williamsi* Wirth: b, head and thorax, dorsal; d, head, lateral; f, pretarsus, lateral. *A. femoralis* Tenorio, n. sp.: e, front femur and tibia, posterior.

Face somewhat convex or carinate medially; three to four facial bristles developed, a series of about six parafacials directed lateroventrad and weaker than the facials. Ocellars parallel and situated cephalad of anterior ocellus; ocellar tubercle distinctly removed from the sharp vertex. Second antennal segment setulose, third seldom longer than broad. Mesonotum and scutellum with irregularly arranged setulae.

Discocerina mera Cresson (fig. 120d)

Discocerina mera Cresson, 1939, Notul. Nat. 21:6. Type female in Academy of Natural Sciences, Philadelphia.

Hawaii, Oahu. First reported on Oahu by Adachi (1952).

Immigrant. Described from Formosa; Guam, Palmyra Island.

Small black species with middle and hind tarsi yellowish, halteres white, and hyaline-brown wings with pale veins. *Head*: Frons with the following bristles well developed: ocellars parallel and slightly cephalad of anterior ocellus, proclinate and reclinate orbitals, inner and outer verticals, and parallel proclinate post-ocellars at or near the sharp vertex. Face somewhat convex and slightly carinate above, with indications of longitudinal grooves on the carina. Four well-developed facials and a series of about six ventrolaterally directed parafacials, weaker than the facials. Gena setulose with one strong genal bristle. Second antennal segment setulose above, third segment short pubescent and about as long as broad; arista with long dorsal rays. *Thorax*: Prescutellar acrostichals and intra-alars very close to the scutellar suture. A few notopleural setulae present, in addition to two notopleurals. Four strong scutellars; disc of scutellum setulose. Mesopleura setulose, especially the anterior half, the posterior margin with two strong mesopleurals. Sternopleura with a few setulae in addition to the single strong bristle. Femora and tibiae black, front tarsi brownish, middle and hind tarsi yellowish, except the two or three apical tarsomeres. Halteres with whitish knobs and brown to black base. Wings hyaline-brown with yellowish veins; costa extending to fourth vein, though weak beyond third; third costal sector a little over one-half the second sector. *Abdomen*: Setulae irregularly arranged as on mesonotum; somewhat opaque above, otherwise shiny black. Female ventral receptacle as in figure 120d.

Length: body, 1.9–2.5 mm.

Little information is available on the biology of this species. Several specimens were collected along the margin of a semi-brackish pool near the seashore, and a few specimens were captured in a light trap.

Genus **HOSTIS** Cresson

Hostis Cresson, 1945, Trans. Am. ent. Soc. 71:64. Type-species, *guamensis* Cresson, by monotypy.

This monotypic genus is characterized as follows:

Face broad and flattened, two facials situated very low on face in line with the lower margin of eye. Notopleura not setulose, but two notopleural bristles present, scutellum setulose. Mesonotal bristles include presutural, intra-alar, and a pair of prescutellars close together and in line with the intra-alar. Two pairs of scutellars, with the apical ones approximate and the marginal ones closer to the scutellar suture than to the apicals. Two notopleurals, two mesopleurals, and one sternopleural bristle.

Hostis guamensis Cresson (fig. 120b)

Hostis guamensis Cresson, 1945, Trans. Am. ent. Soc. 71:64. Type female in U.S. National Museum.

Oahu, Maui.

Immigrant. Described from the island of Guam in the Marianas Islands, and since seen only from Canton Island and the Hawaiian Islands. It was first reported from Oahu by Adachi (1952) from two specimens, both of which were collected on a beach. Through the courtesy of Dr. W. W. Wirth, U.S.D.A. at the U.S. National Museum, I have had the opportunity of examining the two specimens on which this report was based. One of them is not *H. guamensis*, but rather, *Paratissa semilutea* (Loew), a species previously not known to occur in Hawaii. Maui is a new island record; Palmyra Island is also a new record.

The type was taken in Guam from an airplane: "China Clipper, ports Alameda, Cal., Hon., Midway, Guam." Since this species has not been collected in California, it is possible that it got into the plane at Honolulu. The Honolulu airport is close to the seashore where this species is known to occur.

Generally opaque, cinereous species with abdomen relatively shining. Antennae, halteres and wing veins, and middle and hind tarsi (except apical tarsomeres) reddish brown. Frons and face almost vertical in profile. Postocellars well developed, parallel and proclinate, and situated between the posterior ocelli. Ocellars cephalad of anterior ocellus and in line with the reclinate fronto-orbitals. One strong and one weak proclinate fronto-orbital, the latter situated caudad of the former. Arista with two long and two short, widely spaced, aristal hairs. Abdomen somewhat shining; apical margin of terga four and five in male (five and six in female) with several strong bristles. Female ventral receptacle as in figure 120b.

Genus **PARATISSA** Coquillett

Paratissa Coquillett, 1900, Can. Ent. 32:36. Type-species, *Drosophila pollinosa* Williston, by original designation, = *semilutea* (Loew).

Close to *Discocerina*, but distinguished by the presence of three pairs of well-developed bristles on the mesofrons.

The genus is identified primarily by the chaetotaxy of the head. Four pairs of fronto-orbitals present, the uppermost shortest, and the next pair anterior to

it longest; the two lower pairs proclinate, the two upper pairs laterocline and diverging. Frons with a pair each of proclinate postocellars and ocellars (in line with or slightly cephalad of anterior ocellus); an additional pair of bristles present in front of the ocellars in line with the second of the lower fronto-orbitals.

Paratissa semilutea (Loew) (fig. 120e)

Cacoxenus semilutea Loew, 1869, Berl. ent. Z. 13:51. The type of this species is lost (Sturtevant and Wheeler, 1954).

Drosophila pollinosa Williston, 1896, Trans. ent. Soc. Lond. 1896:414.

Paratissa pollinosa, Coquillett, 1900, Can. Ent. 32:36.

Paratissa semilutea (Loew), Wirth, 1965, U.S. Dept. Agr. Handb. 276, pl. 240.

Oahu, Maui. First reported from Oahu, 1946, by Adachi (1952, misidentified as *Hostis guamensis*). Maui is a new island record.

Immigrant. First described by Loew (1869) from Cuba. Williston (1896) described the same species from St. Vincent Is. as *Drosophila pollinosa* which was subsequently used as the type of genus *Paratissa* by Coquillett (1900).

Opaque brown species, with the abdomen darker and somewhat shining. Mesonotum and scutellum setose, not seriated. Mesopleura also setulose, with two distinctly longer bristles along posterior margin. Legs reddish brown, concolorous with the second antennal segment, the halteres, and the wing veins. Face generally grayish brown, reddish brown along the epistomal margin; two strong and one weak (ventral) facials situated very low on face. Abdomen with apical margins of terga five and six of the female and five of the male bearing relatively long bristles. Female ventral receptacles as in figure 120e.

The immatures of this species are still unknown. Adults have been found mostly on dried seaweed washed up onto the beach. Adults can often be seen crawling out from under seaweed piles when the seaweed has been disturbed.

Genus **DISCOMYZA** Meigen

Discomyza Meigen, 1830, Syst. Besch. europ. zweifl. Insekt. 6:76. Type-species, *Psilopa incurva* Fallén, by monotypy.

In his revision, Cresson (1939:1) characterized the genus as follows: "recognized by the general scabrous to granulose surfaces of the thorax and abdomen (except in *vortices* Becker), flattened head with its sharp vertex, wrinkled face (except in *u-signata*), rounded postbuccal area, no discal mesonotal bristles except the prescutellar pair. All the known species are destitute of pollinose vestiture except as forming some minute designs in *incurva* and *u-signata*."

The larvae are "necrophagous in shell of land snails, particularly those occurring near saline water" (*ibid.*).

A single immigrant species of this genus occurs in Hawaii.

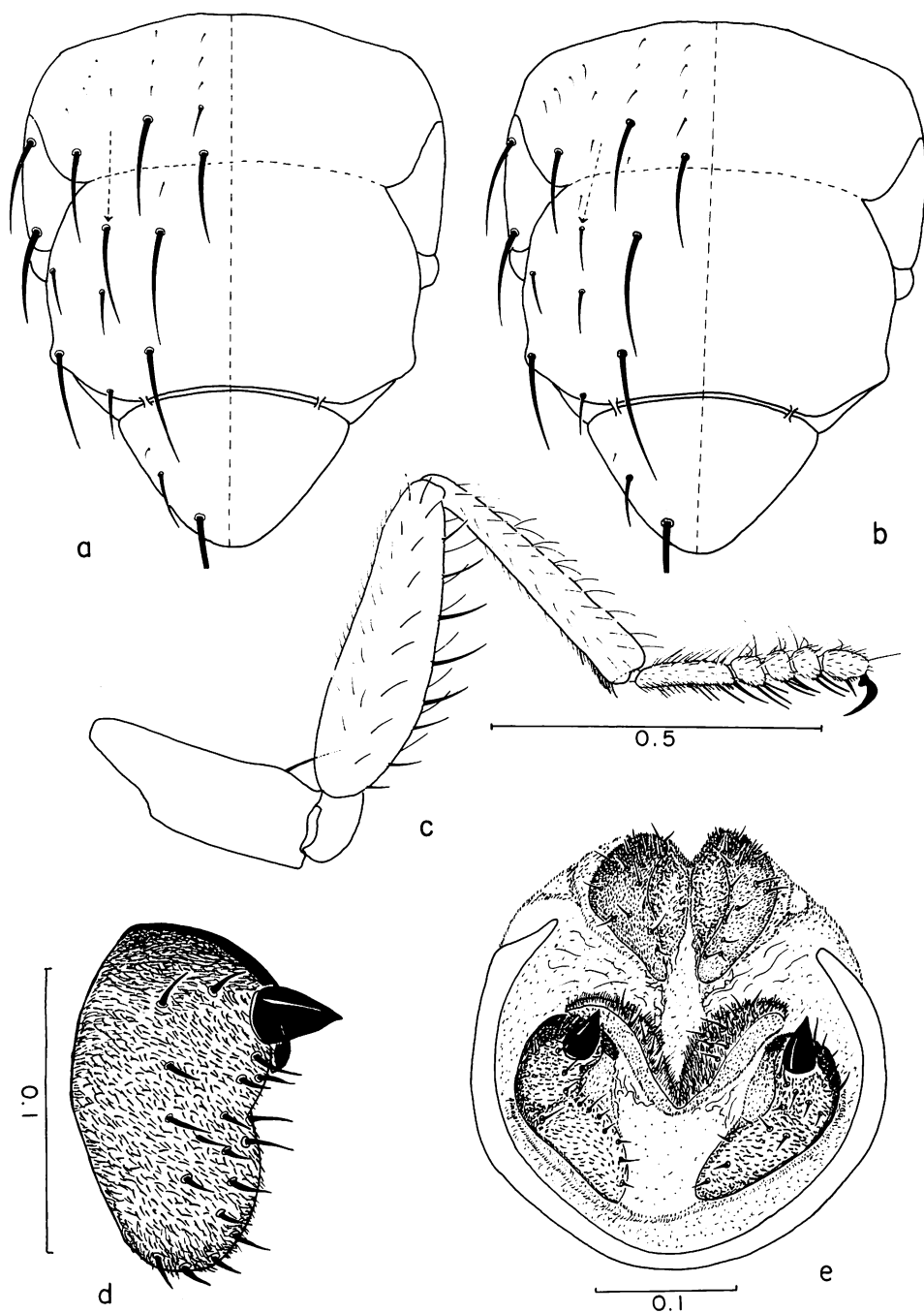


Figure 116—*Neoscatella fluvialis* Tenorio, n. sp.: a, thorax, dorsal. *N. amnica* Tenorio, n. sp.: b, thorax, dorsal; c, front leg, posterior. *N. clavipes* Wirth: d, cercus of female; e, apex of female abdomen, posteroventral.

Discomyza maculipennis (Wiedemann) (figs. 112d, 120c)

Notiphilia maculipennis Wiedemann, 1824, *Analecta ent.* p. 57. Type in Naturhistorisches Museum, Wien.

Discomyza maculipennis de Meijere, 1908, *Tijdschr. Ent.* 51:166.

A complete list of synonymies is given by Cresson (1925:242).

Oahu and Lisianski I., the latter a new island record.

Immigrant. Described from the East Indies and presently widely distributed.

Head rather flat, the face and frons almost vertical in profile. Face, frons, and gena all shiny black; face with somewhat metallic iridescence. Head bristles relatively short; fronto-orbitals placed equidistant from the eye margin, the anterior greatly reduced and proclinate. Facials weak and hair-like. Gena setulose and with one distinct genal bristle. Thorax opaque black, granulate, with patches of gray pollen on mesonotum and mesopleura. Scutellum, mesonotum, and mesopleura setulose. Notopleura pollinose gray, bare, except for two short notopleurals. Legs dark brown, except middle and hind tarsi which are yellow (5th tarsomere light brown). Fore femur swollen, shiny brown to black, and apical one-third emarginated ventrally. Halteres with yellow knob and brown base. Wings with brown markings as follows: a small spot over the r-m crossvein; a large spot extending from the costa across the middle of the wing over the m crossvein to $M_3 + Cu_2$, forming a somewhat interrupted band tapered toward the m crossvein; another large spot at apex of wing, narrowly connected to the middle band along the costal margin. *Abdomen*: Setulose like the scutellum, subshining black. Male genitalia as in figure 112d. Female ventral receptacle (fig. 120c) thimble-shaped, about three-fourths as wide as long.

The first report of this species in Hawaii was made by Bryan (1926) from specimens he bred from improperly cleaned seashells collected on the Whippoorwill Expedition. Most subsequent collections have been made from dead snails, particularly the Giant African Snail, *Achatina fulica* Bowdich.

Genus **CEROPSILOPA** Cresson

Ceropasilopa Cresson, 1917, *Ent. News.* 28:240. Type-species, *nasuta* Cresson, by original designation.

Batula Cresson, 1940, *Acad. Nat. Sci. Phila.*, *Notul. Nat.* 38:2. Type-species, *Psilopa mellipes* Coquillett, by original designation.

This genus has the antennae with the first segment conspicuously exerted, almost as long as wide; the second segment conical; and the third segment elongate. The arista has as many as 12 long dorsal rays; ocellars situated caudad of anterior ocellus, almost between the posterior ocelli; inner and outer verticals and two orbitals equally developed; proclinate orbitals closer to eye margin than the reclinate; face narrowed at middle, convex, most prominent

close to the epistoma; mouth small, clypeus exposed, cheeks with a distinct bristle; mesonotum convex; and wings with costa continuing to fourth vein.

Only one species of *Ceropsilopa* occurs in Hawaii.

***Ceropsilopa coquilletti* Cresson (fig. 121a)**

Ceropsilopa coquilletti Cresson, 1922, Ent. News. 33:136. Type female in Cornell University collection.

Present on all the main islands. First reported from Oahu by Adachi (1952). It was subsequently collected, but not reported, from all the major islands. This report, therefore, constitutes new records for all the major islands, except Oahu.

Immigrant. Described from California.

Small, shiny brown to black species, with yellow legs, brownish yellow wings, and white halteres. *Head*: Face convex, shiny brown to black, and transversely wrinkled. Facials in a row of four, the uppermost longest and directed inward. Eyes large, flaring at mid-face in profile, margin sinuate at level of antennae. Gena very narrow below eyes and with one distinct genal bristle about as strong as the uppermost facials. Ocellars, inner and outer verticals, reclinate and proclinate orbitals equally developed; ocellars divergent and placed caudad of the anterior ocellus, between the posterior ocelli; proclinate orbitals closer to the eye margin than the reclinate orbitals. Palpi black. *Thorax*: Mesonotum conspicuously convex. Prescutellar acrostichals, and intra-alars at about the same level, postalars situated more posteriorly; all bristles equally developed. Four scutellar bristles present, the basal ones very close to the scutellar suture and aligned with each other, along with two long mesopleurals and a few scattered fine setulae. Sternopleura light pollinose gray, shiny beneath; one strong and one weak sternopleural. Legs all yellow. Wings hyaline brownish yellow. Halteres yellow or white. *Abdomen*: Generally polished brown to black, with first three segments somewhat opaque brown above. Female ventral receptacle as in figure 121a.

Cresson gave the length of the type as 2.85 mm. Specimens in Hawaii range from 1.2 mm. to 1.8 mm. in length.

Little is known of the biology of this species. I have not seen the immature forms. Some of the specimens which I have examined were collected or reared from various plants, which may indicate a phytophagous habit. Thirteen specimens were collected by M. S. Adachi on *Sesuvium portulacastrum* L., a coastal herb in the carpetweed family and called "akulikuli" in Hawaii. Twenty-six specimens were collected by D. E. Hardy on *Atriplex* sp., probably *A. semibaccata* R. Br., an Australian salt bush which "grows in arid or salty soil, introduced to Hawaii for forage" (Neal, 1965:331). J. W. Beardsley reared a specimen from grass infested with mealybugs. Nine specimens were reared from *Nothocestrum* sp. (tomato family). Other material has been taken along margins of ponds on sedges and grasses.

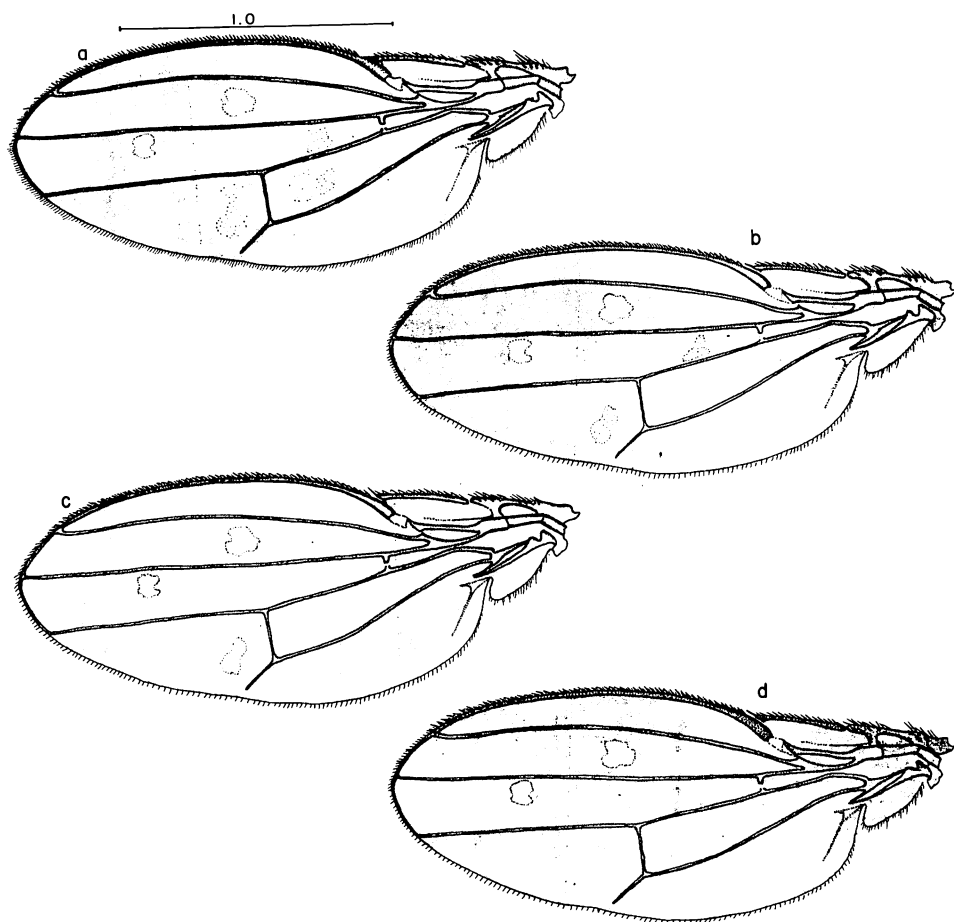


Figure 117—*Neoscatella oahuensis* (Williams): a-d, wings showing varying numbers of spots.

Genus **CLASIOPELLA** Hendel

Clasiopella Hendel, 1914, Supplta. ent. 3:109. Type-species, *uncinata* Hendel, by original designation.

Very similar to *Psilopa* from which it is distinguished by the prominently convexed face (convexity limited to the upper part of the face), the long femoral post-flexor bristles, about twice the diameter of the femur, and the two sternopleural bristles.

A summary of the major characters of the genus is given below.

Head with frons two times as wide as long, slightly narrower anteriorly. One proclinate and one reclinate fronto-orbital, the former closest to the eye margin. Inner and outer verticals well developed; divergent postverticals present, although relatively short. Ocellars proclinate and parallel, placed behind

the level of the anterior ocellus. Face pollinose gray and with a prominent median facial hump restricted to upper half of face; two pairs of facials, the upper pair cruciate and located just below the middle of face. Gena narrow anteriorly and with a strong genal, wide posteriorly and setulose. Antenna matt brown to black; second segment with a strong seta at upper apical corner; arista with long dorsal rays. Thorax with the following bristles well developed (in pairs): one humeral, one presutural, one intraalar, one postalar, one postsutural dorsocentral, two scutellars, two notopleurals, one mesopleural, and two sternopleurals. Front femur with four long post-flexor bristles. Wings brown, halteres yellow.

Only one species of this genus is known to occur in Hawaii.

***Clasiopella uncinata* Hendel (figs. 112a-c, 121d)**

Clasiopella uncinata Hendel, 1914, Supplta. ent. 3:110. Three syntypes in the Deutsches Entomologisches Institut.

Hawaii, Molokai, Oahu. First recorded from Oahu by Adachi (1952). Molokai and Hawaii are new island records.

Immigrant. Described from Formosa as the only included species of the genus. Presently known also from the Australasian Region. Cresson (1946a) records this species as captured in Florida in an airplane from the West Indies.

Small shiny black species with legs and halteres yellow, and humeral callus with whitish gray pollen. Head with frons twice as wide as long, subshining black. Outer verticals about two-thirds the length of the inner vertical. Postverticals divergent, placed between the posterior ocelli. Ocellars proclinate and parallel, located closer to the posterior ocelli than to the anterior ocellus. Proclinate and reclinate fronto-orbitals close to each other, the proclinate one closest to the eye margin. Antenna dark brown to black; second segment mesally with a long seta at the anterior ventral margin, about as long as the seta at the upper apical corner; third segment about one-half as wide as long; arista twice as long as the second segment, with nine or ten long dorsal rays. Face pollinose gray with prominent median facial hump. Two facials, the upper pair cruciate and located laterad of the ventral extension of the median facial hump. One strong genal. Thorax mesonotum and scutellum shiny black. Mesonotal setulae seriated; one row each of acrostichals and dorsocentrals, both rows terminating in front of the postsutural dorsocentral. Scutellum with a few hairs on disc. Anterior scutellars as close to the scutellar suture as one-half the distance between the apical scutellars. Humeral callus with whitish gray pollen. Both notopleurals placed very close to the notopleural suture and aligned with the humeral bristle. Mesopleura setulose, in addition to having one long bristle at the posterior margin below middle. Two sternopleurals, the anterior shorter than the posterior. Wings dark brown; costa extending to fourth vein, although weak beyond the third vein; costal setae ending at third vein. Halteres yellow to white. Legs yellow, except the fifth tarsomeres which are brown. Front femur with two to four long post-flexor

bristles. Middle and hind femora at anteroapical one-third with three to four relatively strong bristles. Male genitalia as in figure 112a,b. Female ventral receptacle as in figure 121d and female eighth sternum in figure 112c.

The immature forms of this species are unknown. Adult flies have been found on vegetation along margins of freshwater ponds, generally occurring in association with adults of *Psilopa olga* Cresson.

Genus **PSILOPA** Fallén

Psilopa Fallén, 1823, Hydromyzides Sveciae, Lund. p. 6. Type-species, *Notiphila nitidula* Fallén, subsequent designation (Rondani, 1856:132).

This genus is very similar to *Clasiopella* Hendel, particularly in general coloration and chaetotaxy. Chaetotaxy of the face, frons, and mesonotum is very much the same in both genera. *Psilopa* may be distinguished by having a row of post-flexor bristles on the front femur which are relatively short, no longer than three-fourths the diameter of the femur; in *Clasiopella*, the post-flexor bristles are longer than the diameter of the femur. In profile, the face of *Psilopa* is practically flat; in *Clasiopella*, the face is convex.

Only one strong bristle is present on the sternopleuron, although two minute setulae may be evident anterior to this bristle.

One species of *Psilopa* occurs in the Hawaiian Islands.

Psilopa olga Cresson (fig. 121e)

Psilopa olga Cresson, 1922, Ent. News. 33:137. Type male in U.S. National Museum.

Psilopa dimidiata Cresson, 1922, Ent. News. 33:137. Type male in Washington State University collection.

Oahu, Kauai, Maui, Hawaii. The latter three are new island records. First reported from Oahu as *Psilopa girschneri* von Roeder (Hardy, 1952:468).

Immigrant. Described from North America (Washington State).

Shining black species with face pollinose, easily recognized by the distinct wing markings: Two black spots, one each at the apex of the fourth and fifth longitudinal veins; the spot on the fifth vein smaller and somewhat faint, particularly in female specimens. Tarsi, except the apices, yellow; halteres white. Ventral receptacle of female as in figure 121e.

Many adults of this species have been collected along margins of ponds. In places where I have personally collected this species, adults were observed feeding along the muddy margins of ponds, the waters of which were stagnant and odoriferous. Samples of pond water and mud were examined, but no immatures were found.

Genus **DONACEUS** Cresson

Donaceus Cresson, 1943, Trans. Am. ent. Soc. 69:5. Type-species, *nigronotatus* Cresson, by monotypy.

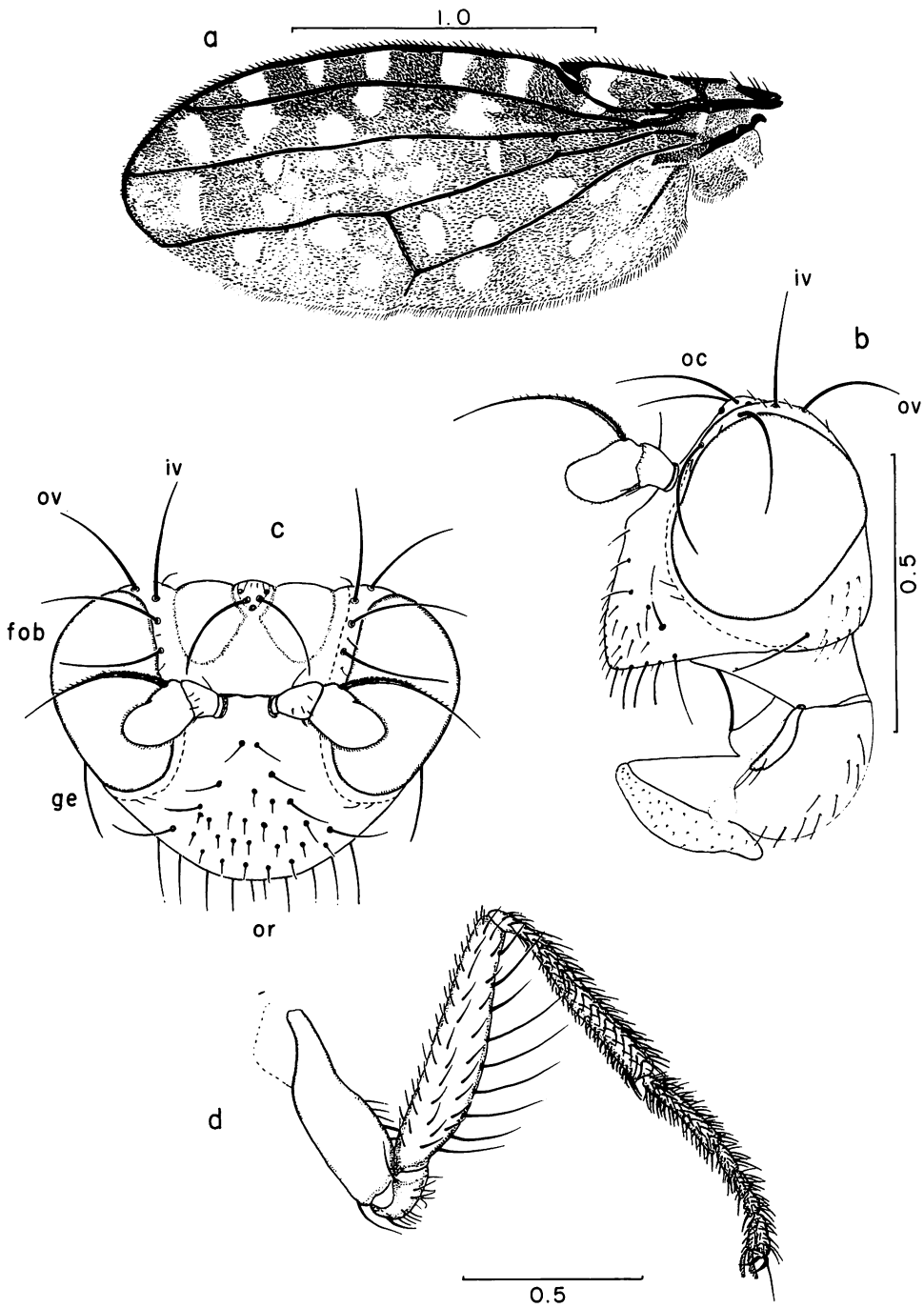


Figure 118—*Scatella wirthi* Tenorio, n. sp.: a, wing; b, head, lateral; c, head, anterior. *Neoscatella warreni* (Cresson): d, front leg of male (Oahu and Kauai).

This genus was proposed by Cresson to include a single species from Formosa. The major differentiating characters of the genus are the presence of two posterior dorsocentrals, the setation and structure of the frons and face, and wing venation and markings.

The frons is flat, without any noticeable depressions or elevations, almost horizontal in profile. The face is bare centrally, convexed, widest at epistomal margins, and with three strong facials. Thorax with acrostichals and dorsocentrals strong, the latter with one presutural and two postsuturals. A pair of strong prescutellars is present approximately in the same line as the row of acrostichals. Scutellum convex, with two pairs of scutellars. Abdomen black.

In his description of the genus, Cresson (*ibid.*) states, "Postocellars situated between the posterior ocelli." After examining large numbers of *D. nigronotatus* Cresson, the single species in the genus, I have found that the bristles present between the postocelli are not postocellars, but, in fact, ocellars.

***Donaceus nigronotatus* Cresson (figs. 114d-e, 121c)**

Donaceus nigronotatus Cresson, 1943, Trans. Am. ent. Soc. 69:5. Type female in Philadelphia Academy of Natural Sciences.

Kauai, Oahu, Maui, Hawaii. The latter two are new island records. First reported from Kauai and Oahu by Hardy (1965).

Immigrant. Described from Formosa. Presently known from the type locality, Thailand, Okinawa, Biak I. (N. Guinea) and the Hawaiian Islands.

Relatively small species, with head and thorax ochraceous, abdomen black, and wings with brown markings. Face convex, ochraceous on upper three-fourths and silvery along epistomal margin; three facials, the upper one directed mesodorsally and the lower mesoventrally. Genal bristle located well forward and very close to lower eye margin. Two fronto-orbitals, both laterocline, although the anterior is somewhat procline and the posterior somewhat reclinate. Ocellars (postocellars of Cresson) divergent and located between the posterior ocelli. Thorax with three acrostichals, the anterior-most located at or near the suture; a pair of prescutellars approximately in the same row as the acrostichals. Three dorsocentrals, one presutural and two postsutural. One intraalar slightly in front of the line of prescutellars. Scutellum strongly convex, with a black spot on each side of the apex; two scutellars, the anterior slightly closer to the scutellar suture than to the posterior or apical, both within the black spot. Two notopleurals, the posterior longer than and farther removed from the notopleural suture than is the anterior. One strong mesopleural and one weak dorsal to the strong one. Sternopleura also with one strong bristle and one weak bristle ventral to it. Legs (except fifth tarsomere which is brown) and halteres yellow. Wings with brown and white patterns throughout, the longitudinal veins wavy; second costal sector more than twice as long as third sector. Abdomen black, covered with gray pollen. Female ventral receptacle as in figure 121c; eighth sternum as in figure 114e. Male genitalia as in figure 114d.

I have not seen the immature forms of this species, although I have collected

adults from at least two islands in various kinds of habitats. What appears interesting about this species is that it seems to thrive equally well at low and high elevations, ranging from near sea level to upwards of 4000 ft. in elevation. While found in different situations, such as ponds, swamps, reservoirs, and streams, *D. nigronotatus* is always found along the margins of these bodies of water where the surface is muddy. I have observed adults vigorously lapping and scraping the surface of the mud with their proboscis, presumably ingesting microorganisms and other small organic particles.

Genus **HYDRELLIA** Robineau-Desvoidy

Hydrellia Robineau-Desvoidy, 1830, Mém. Sci. Math. Phys., Acad. Roy. Sci. 2:790. Type-species, *aurifacies* Robineau-Desvoidy, by subsequent designation (Westwood, 1840:153), = *flaviceps* (Meigen).

This genus contains a large number of cosmopolitan species. According to Berg (1950), all of the *Hydrellia* larvae of known habits are phytophagous, most mining leaves and stems of aquatic plants, others preferring terrestrial plants, particularly grasses. The genus has been studied extensively by Cresson (1932, 1935, 1944).

Cresson (1944:163) characterized the genus under the tribe Hydrellini as follows: "ocellars are rarely stronger than the postocellars and are sometimes scarcely discernible; the eyes are pilose and the second antennal segment is with or without minute spine; the humeral and supraalar are usually weak and the posterior notopleural is not removed dorsad from the margin; the costa extends to the fourth vein. The face is generally evenly convex but in a few species is prominent and somewhat carinate, without any median tuberosity; the facials are relatively fine, hair-like and non-cruciate; arista with long hairs; there are always one to three dorsocentrals present."

Two species occur in Hawaii, one of which is endemic.

KEY TO SPECIES OF HYDRELLIA IN HAWAII

1. Frons and antennae velvety black. One pair of dorsocentrals at or near the suture. Smaller species. **williamsi** Cresson.
- Frons dark brown, black along the lateral margins; third antennal segment yellow. Three pairs of dorsocentrals, one presutural and two post-sutural. Larger species. **hawaiiensis** Cresson.

Hydrellia hawaiiensis Cresson (fig. 121g)

Hydrellia hawaiiensis Cresson, 1936, Trans. Am. ent. Soc. 62:259. Type male in Academy of Natural Sciences in Philadelphia.

Endemic. Oahu (type locality: Waianae) and Hawaii. Specimens from Hawaii constitute a new record for that island.

H. hawaiiensis differs from *H. williamsi* in its larger size, in having the frons not velvety, and in possessing three pairs of dorsocentrals.

Generally grayish with third antennal segment, tibiae, tarsi, and halteres yellow to reddish brown. Face niveous, shaped like an inverted Y. Five fine, but long, facials. Genae grayish. Frons dark brown, black along the lateral margin between the orbital plate and the mesofrons. Antenna with first and second segment velvety black, third yellow. Mesonotum with three pairs of dorsocentrals, one in front and two behind the suture; acrostichals short, except for one pair of prescutellars slightly caudad of the strong intra-alars. Female ventral receptacle as in figure 121g.

Almost nothing is known of the immatures of this species. Regarding the eggs, Williams (1938:90) made the following comments: "egg much like that of *H. williamsi* is yellowish white and ribbed, but is somewhat larger, measuring about 0.53 mm."

The habits of this species in the adult stage are poorly known. Williams (1938) found adults walking on the surface of water, as well as on algal mats consisting largely of *Enteromorpha* sp. I have collected specimens in flowers of *Anacharis* sp. growing in Waiakea Pond in Hawaii. I have also observed adults on rotting *Anacharis* sp. along the margin of the same pond. Samples of the *Anacharis* were examined thoroughly, but no immatures were found. I also tried, unsuccessfully, to obtain eggs by placing several adults of both sexes in a gallon jar with a layer of *Anacharis*.

Hydrellia williamsi Cresson (fig. 121f)

Hydrellia williamsi Cresson, 1936, Trans. Am. ent. Soc. 62:259. Type male in Academy of Natural Sciences of Philadelphia.

Oahu (type locality: "Kukala" Val., Waianae Mts.) and Molokai (reported by Williams, 1938). Additional specimens have been examined from the island of Hawaii, for a new island record.

Immigrant. Australia, New Zealand.

This species is easily distinguished from *H. hawaiiensis* by its smaller size, velvety frons and antenna, and the single pair of dorsocentral bristles.

Thorax dark brown to black, abdomen shining black, legs and halteres yellowish. Antennae and frons, including the ocellar tubercle, velvet black. Face silvery, rectangular in shape. Mesonotum somewhat shining dark brown; one pair of dorsocentrals at or behind the suture; a pair each of presutural and intraalar bristles, both strong. Female ventral receptacle as in figure 121f.

H. williamsi is a miner in leaves of *Lemna*. The biology and immatures of this species are discussed in the section on immatures below.

Genus **NOTIPHILA** Fallén

Notiphila Fallén, 1813, K. Vetensk. Akad. Handl. p. 22. Type-species, *cinerea* Fallén, by subsequent designation (Westwood, 1840:153).

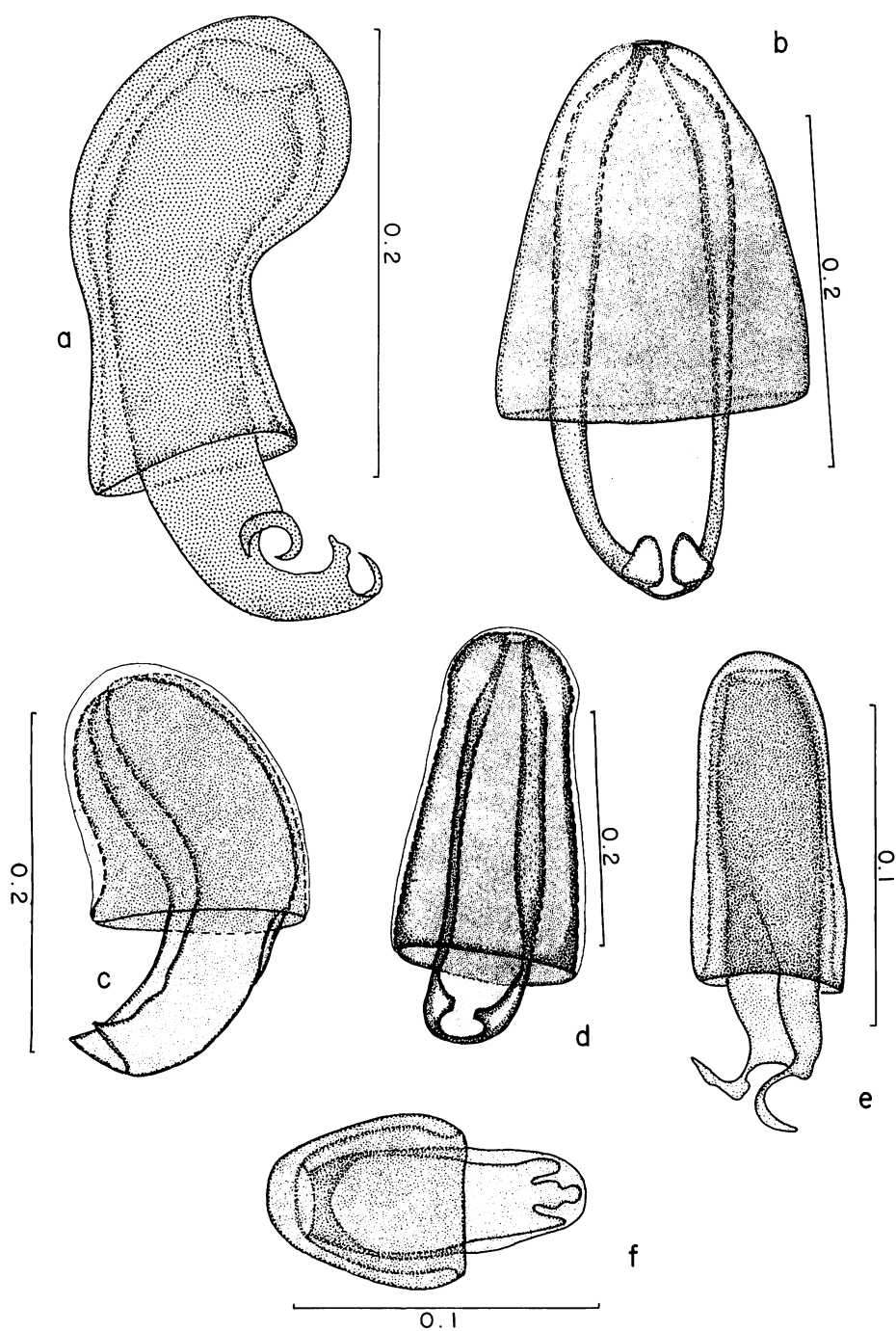


Figure 119—Ventral receptacles: a, *Chlorichaeta albipennis* (Loew); b, *Mosillus grandis* (Cresson); c, *M. tibialis* Cresson; d, *Placopsidella cynocephala* Kertész; e, *Atissa antennalis* Aldrich; f, *A. oahuensis* Cresson.

Members of this genus have the costa terminating at the apex of the third vein; one sternopleural; two notopleurals close to the notopleural suture, the anterior one stronger than the posterior, and the middle tibia with at least three erect bristles on the dorsal surface.

The genus consists of two subgenera, *Notiphila* Fallén and *Agrolimna* Cresson, distinguished from each other as follows: *Notiphila* with three erect dorsal bristles on middle tibia, hind metatarsi basally with black setae, middle femora of male with ventral comb, and male external claspers greatly reduced; *Agrolimna* with four dorsal bristles on middle tibia, hind metatarsi with yellow or pale brown setae, middle femora without ventral comb, and male external claspers well developed (Cogan, 1968).

A single species of the subgenus *Notiphila* is present in Hawaii.

***Notiphila (Notiphila) insularis* Grimshaw (fig. 121b).**

Notiphila insularis Grimshaw, 1901, Fauna Hawaiiensis. 3:49. Type in the British Museum (Natural History).

Endemic. Oahu (type locality: Wailua, Koolau Range) and Molokai. Specimens from Hawaii and Kauai constitute new island records.

In the early literature subsequent to Grimshaw's description, this species was referred to as *Paralimna insularis* (Grimshaw) (Bryan, 1934 and Williams, 1938). Hardy (1952:468) reverted to the original combination upon confirmation of the correct genus by Dr. W. W. Wirth.

Grayish species with patches of brown on the abdomen. The antennae and legs, except the femora, are reddish brown; palpi and halteres are yellow. Fronto-orbitals with only the reclinate pair present. Frons, face, and gena grayish, with frons slightly darker. Two pairs of dorsocentrals, one in front and one behind the suture. Acrostichals absent, except for a pair of prescutellars. Other strong bristles on mesonotum include: one pair each of humerals, presuturals, supraalars, intraalars, and postalars. Two pairs of equally strong scutellars. Two notopleurals (posterior one weaker), two mesopleurals (upper one weaker), and one sternopleural. Abdomen with patches of brown over gray background and apical margin of third to fifth terga with long bristles. Female ventral receptacle as in figure 121b.

Adult flies are generally found on vegetation in or along margins of fresh water bodies, particularly calm water. At Waimanalo, Oahu, I observed several individuals in a canal choked with water hyacinths, water lettuce, and *Lemna* spp. I also collected adults from a fish pond filled with water hyacinths at Kapaa, Kauai. Unfortunately, no immatures were ever found. Other than these superficial observations, nothing is known of the biology of *N. insularis*.

Genus **BRACHYDEUTERA** Loew

Brachydeutera Loew, 1862, Smithsonian Misc. Coll. 114:162. Type-species, *dimidiata* Loew, by monotypy.

This genus has the wings with the costa ending at the third vein, second vein short and curved toward the costa, and the second costal sector one-third as long as the third sector; the mouth opening large and gaping, with clypeus exposed; the frons with a pair of interfrontals, three pairs of orbitals directed laterally over the eye; and the arista with as many as ten dorsal rays.

Wirth (1964) has revised the genus.

Adult members of the genus are characteristically water-skaters found mostly on surfaces of small, quiet bodies of water such as ponds, pools, puddles, and even tree holes and discarded containers. They feed on microorganisms and organic particles floating on the water surface. The larvae are aquatic and found generally in shallow water, feeding primarily on microorganisms and decaying plant and animal material. While these flies are predominantly scavengers, at least one species, *B. hebes* Cresson, has been reported parasitizing the liverfluke snail, *Lymnaea ollula* Gould, in Hawaii (Davis, 1959).

One species of *Brachydeutera* is found in Hawaii.

***Brachydeutera hebes* Cresson (figs. 113a-f, 122a)**

Brachydeutera hebes Cresson, 1926, Proc. Haw. ent. Soc. 6:277. Type and allotype in the B. P. Bishop Museum.

Brachydeutera argentata of authors, not Walker; misidentification.

Endemic. Oahu (type locality: Kalihi), Kauai, Molokai, Maui, Hawaii, and Kahoolawe. The latter is a new island record.

This species was misidentified as *B. argentata* Walker and first reported from Hawaii by L. O. Howard (1901) and by P. H. Grimshaw (1901).

Largest of the endemic ephydrids, this species is dark brown to black with silvery gray genae, coxae, lower portion of the abdomen, face (except the prominent carina which is brown) and most of the thoracic pleura. Thorax, in dorsal view, is shown in figure 113e; abdomen, figure 113a-d; wing, figure 113f; and female ventral receptacle, figure 122a. A detailed description of this species is given by Wirth (1964).

Williams (1938) gave detailed information on the habits, habitats, life cycle, and immature stages of this species. The adult fly is an excellent water-skater, found most abundant in the lowlands occupying great varieties of quiet pools and other small bodies of water whose bottoms are littered with leaves and other plant parts in various stages of decay. Stagnant pools, some of which have their surfaces covered with scum or algae and which emit a putrid odor, are not uncommon habitats for these flies. At higher elevations, small puddles diverted from streams or those which collect in the rain forests serve commonly as breeding sites for *B. hebes*. It has also been seen in three holes filled with water and in artificial containers, such as water tanks or discarded oil drums. On one occasion, in Olaa Forest in Hawaii, I found two fully-grown larvae in a discarded aluminum foil container (4 x 6 x 2 in.) half-filled with water and rotting leaves; these larvae were subsequently reared to adulthood.

Both as adults and as larvae, these flies are scavengers feeding on microscopic organisms and particles of plant and animal material. The adults occupy the surface of the water, while the larvae concentrate beneath the surface.

The larvae of this species, in one case, were reported to be parasitic by Davis (1959). He observed the larvae "attacking and killing local populations of the liverfluke snail, *Lymnaea ollula* Gould." In laboratory studies, Davis observed six larvae in one snail and out of 10 adult *Lymnaea*, three were "consumed" over a period of three days.

For descriptions of larvae and pupae and details of the life history of *B. hebes*, refer to the section on immatures below.

Genus **HYADINA** Haliday

Hyadina Haliday, 1839, Ann. Nat. Hist. 3:406. Type-species, *Notiphila guttata* Fallén, by subsequent designation (Westwood, 1840:153).

Cresson (1949) treated *Axysta* Haliday, *Lytogaster* Becker, and *Hyadina* Haliday as separate genera. Sturtevant and Wheeler (1954), however, included *Axysta* and *Lytogaster* under the genus *Hyadina*, primarily because of lack of satisfactory generic characters. In the *Catalogue of Diptera of North America*, Wirth (1965) apparently continued Cresson's classification of three separate genera. A revision of this group is evidently needed in order to resolve these different viewpoints. For the purpose of this discussion, I am following Cresson's and Wirth's treatment of the genus and am including a new species from the Hawaiian Islands. This constitutes a new distribution record for the genus *Hyadina*. *H. pullipes* Cresson is known from New South Wales (1930a) and *H. sauteri* Cresson from Formosa (1934a).

Members of this genus are characterized by Cresson (1949:252) as follows:

a genus of small (1.5 to 2 mm. long) flies with reduced chaetotaxy: the only dorsal mesonotal bristles being the posterior intra-alars (sometimes erroneously called the prescutellars); antenna rather porrect, the superior margin of third segment dark, the inferior part pale; face with weak carina and median tuberosity, but with strongly flaring orbits; one (posterior) notopleural; wings immaculate or cross-veins clouded, but sometimes with discal whitish areas; the abdomen with the lateral lobes of the tergites more or less sharply turned under, and the fourth tergite never longer than the fifth.

***Hyadina vittifacies* Tenorio, new species (figs. 114a-c, 122c)**

Small species about 1.6 mm. in length, including head. Shining dark brown to black with vestitures of brown and gray pollen on frons, mesonotum and scutellum; pleura gray-dusted; lower half of third antennal segment, palpi, legs (except front tarsi), wings, and halteres yellowish; frons with velvety black spot at anterior corners between the antennae and eyes; and face with a wide median shining brown strip.

FEMALE. *Head* (fig. 114a, b): Orbitals and outer vertical bristles absent. Ocellars and inner verticals equally strong, the former located between the posterior ocelli. Frons about twice as wide as long, shiny brown to black, lighter anteriorly; anterior corners between antennae and eyes velvety black. Face slightly less than half as wide as long, more prominent at lower third; midfacies shiny brown to black, extending from base of antennae to epistoma, tapering between antennal bases and half as wide as width of face at epistoma; remainder of face silvery. Facials minute and hair-like, two pairs directed inward and two pairs closer to eyes, dorsally directed. Gena narrow, silvery; genals minute and hair-like, as are the facials. Antenna placed about level with the upper margins of eyes, brown, except lower half of third segment; arista short pubescent to three-fourths its length; third segment pubescent, about half as wide as long, lower half yellow. Eyes large, about three-fourths the height of head and from anterior view bulging beyond genae; eyes closest at about mid height of face. Palpi yellow. *Thorax*: Mesonotum and scutellum subshining dark brown to black with vestitures of brown and gray pollen, latter more prevalent at dorsal angle of notopleura to dorsocentral line; pleura pollinose gray. Chaetotaxy reduced and with only the following bristles present: one strong intraalar, the postalar about half as long as the intraalar; two rows of dorsocentrals and one row of acrostichal setulae; one notopleural (anterior notopleural absent); and one each mesopleural and sternopleural, both weak. Scutellum triangular, somewhat rounded at apex, half as long as wide; four marginal bristles, apical pair almost three times as long as the lateral pair, the latter located about half way between the apical pair and the scutellar suture. First and second coxae gray on the anterior surface; femora, tibiae, and tarsi of second and third legs yellowish; sometimes apical tarsomeres brown; tarsi of first pair of legs brown, especially the apical tarsomere. Halteres yellow. *Wings* (fig. 114c): Transparent yellowish brown, veins brown; second costal sector about one and one half times longer than the third. *Abdomen*: Female ventral receptacle as in figure 122c.

Length: Head, width, 0.62 mm.; height, 0.4 mm.; length, 0.32 mm. Body, 1.6 mm.; wings, 1.8 mm.

MALE. Unknown.

Holotype female: Oahu, Honolulu, April 20, 1963 (C. R. Joyce). Five female paratypes: Oahu, Honolulu, September 4, 1968 (C. R. Joyce); same locality, March 24, 1961, and October 8, 1963 (C. R. Joyce). Type and one paratype to be deposited B. P. Bishop Museum, two paratypes in University of Hawaii, one each in U.S. National Museum and the British Museum (Natural History).

Genus **LYTOGASTER** Becker

Lytogaster Becker, 1896, Berl. ent. Z. 41:202. Type-species, *Philygria abdominalis* Stenhammar, by original designation.

This genus is recognized by the "unusually convex, subhemispherical ab-

domen, caused by the shortening of the dorsal part of the second and third segments and elongation of the fourth. The lateral margins are revolute, not sharp and not closing in on the ventral plates. The second and third segments have a more or less distinct, sunken area on the dorsum" (Cresson, 1918:61).

A single member of this genus is present in Hawaii.

Williams (1938:87) made mention of *Lytogaster aldrichi*? Cresson as being present in Hawaii. This is evidently a manuscript name of Cresson's, as pointed out by Hardy (1952:469) and was indicated by Hardy (*ibid.*, p. 467) as a *nomen nudum*.

***Lytogaster grvida* (Loew) (fig. 122b)**

Hyadina grvida Loew, 1863, Berl. ent. Z. 7:325. Location of type unknown (ref. Cresson, 1949:256).

Lytogaster willistoni Cresson, 1916, Ent. News. 27:150. Type male in Academy of Natural Sciences, Philadelphia.

Oahu, Hawaii, Maui, Molokai, Kauai. The latter three are new island records. This species was first known in Hawaii as *Lytogaster willistoni* Cresson and reported from Tantalus Trail, Oahu, by Williams (1938:6).

Immigrant. Described from Alaska.

This species is most readily recognized by its minutely punctured, dorsally convex abdomen, more than two-thirds of the length of the abdomen occupied by the greatly enlarged fourth and fifth segments.

Head and thorax generally brown, with frons and scutellum dark brown to black. Femora and tibiae (except apices) and apical tarsomeres black. Wing veins dark brown to black; halteres brown to black. Abdomen shining black. Female ventral receptacles as in figure 122b.

The immatures of this species are unknown. I have collected several adults along stream margins at Kokee, Kauai, and Mt. Tantalus, Oahu. It is interesting to note that most of the material examined was from relatively high elevations in native forests. This is one of the few immigrant species which has become established in the native Hawaiian forests.

Genus *EPHYDRA* Fallén

Ephydra Fallén, 1810, Specim. Ent. nov. Dipt. Method. Exhib. p. 22. Type-species, *riparia* Fallén, by subsequent designation (Curtis, 1832:413).

The major characteristics of this genus are as follows: tarsal claws relatively long and straight, pulvilli absent or considerably reduced, three pairs of strong laterocline fronto-orbitals, and four or five pairs of dorsocentrals, three of which are postsutural.

The larvae of *Ephydra* are aquatic and are found most commonly in strongly saline or alkaline waters. Adults congregate on the water surface, on vegetation, and on the shores or margins of various bodies of water.

Two species of *Ephydra* occur in Hawaii, both of these relatively large in comparison with other Ephydridae present in the islands.

KEY TO SPECIES OF EPHYDRA IN HAWAII

1. Color whitish gray. Frons with minute setae, opaque to subshining metallic green. Mesonotum completely opaque, whitish gray. Legs pale to reddish brown, especially the tibiae and tarsi. ***cinerea*** Jones.
 Color brownish green. Frons with two pairs of long setae on mesofrons, frons shining metallic bluish green. Mesonotum brownish metallic green. Legs with tarsi and apices of tibiae brown to dark brown. ***milbrae*** Jones.

Ephydra cinerea Jones (fig. 122e)

Ephydra cinerea Jones, 1906, Univ. Calif. Publ. Ent. 1:159. Type in University of California collection.

Oahu, Kauai. The latter is a new island record. First reported from Oahu as *E. gracilis* Packard (Wirth, 1947:141).

Immigrant. Described from California.

E. cinerea may be easily distinguished from the green-colored *E. milbrae* by its whitish gray body.

Generally whitish gray, with halteres and legs, particularly the tibiae and tarsi, yellowish. Frons somewhat metallic green, with scattered minute setulae. Face with short setulae, including the epistomal margin; five to six facials in a diagonal row present. Acrostichals all minute, except the prescutellar (present in female specimens only) which is about as long as the dorsocentrals. Female ventral receptacle as in figure 122e.

Wirth (1947) presents a good description of the habits and habitats of this species on Oahu. The larvae and pupae are found in masses of algae underwater. Apparently, the adults go into the water to oviposit. In July, 1946, Wirth observed literally millions of these flies evidently breeding in salt water-ponds near Moanalua Gardens and, in August of the same year, extremely large numbers were also observed by Wirth in salt marsh pools at Iroquois Point on Oahu.

For descriptions of the larvae and pupae of this species, refer to the section on immatures below.

Ephydra milbrae Jones (fig. 122d)

Ephydra milbrae Jones, 1906, Univ. Calif. Publ. Ent. 1:155. Type in University of California collection.

Oahu, Maui. The latter is a new island record. First reported from Oahu by Hardy (1952) as *E. riparia* Fallén.

Immigrant. Described from California.

This species may be differentiated from the whitish gray *E. cinerea* superficially by its greenish appearance.

Frons metallic bluish green with scattered setulae and two pairs of interfrontals (longer in females). Face with bluish green spot above the facial hump, remainder of face and gena ochraceous; bristles at epistomal margin long in females, short in males. Mesonotum and scutellum somewhat shiny green. Abdomen opaque gray, brownish on apical segments. Female ventral receptacle as in figure 122d.

Jones (*op.cit.*) has given a detailed description of this species, including the immature forms, egg, larva, and pupa. However, the eggs which Jones figured, according to Sturtevant and Wheeler (1954), are not those of *Ephydra*. The larvae and pupae are discussed in the section on immatures below.

On April 4, 1970, I collected a large number of larvae, pupae, and adults in a stagnant pool near the Ala Wai Canal on Oahu. The pool was filled with partially submerged grasses, masses of algae, and assorted debris. The surface of the water was literally covered with adult flies, and larvae and pupae were crawling or clinging to grass blades, stems, algae, and anything else in or on the water. About a month later, when I returned to the pool, the pool had been cleaned and the grass removed, so that the water flowed freely in and out of the area. The resulting conditions were evidently unfavorable to fly breeding, as adult flies were no longer present in this environment.

Many of the puparia collected in this pool were observed to have parasite emergence holes. Consequently, a large number of puparia were placed in gallon jars and the parasites allowed to emerge. The hymenopterous parasite was identified by J. W. Beardsley, University of Hawaii, as *Urolepis rufipes* (Ashmead) (Pteromalidae). The same species of parasite was also reared from the pupae of *Neoscatella sexnotata*, but these individuals were consistently smaller than those which emerged from *E. milbrae*. A few Hydrophilidae larvae were observed feeding on both the larvae and pupae of this fly.

Genus **APULVILLUS** Malloch

Apulvillus Malloch, 1935b, Bull. B. P. Bishop Mus. 114:197. Type-species, *bronneci* Malloch, by original designation.

Chaetoscatella Malloch, 1934, Insects Samoa 6(8):322 (*Nomen nudum*); 1935b, Bull. B. P. Bishop Mus. 114:199. Type-species, *cheesmanae* Malloch, by monotypy.

References: Wirth (1948) for taxonomy and Williams (1938) for biological details.

The synonym *Chaetoscatella* and the status of the genus *Apulvillus* are discussed in detail by Wirth (1948:296) in his revision of the group. Malloch (1935b:197) first defined the genus in his generic key as having "pulvilli ab-

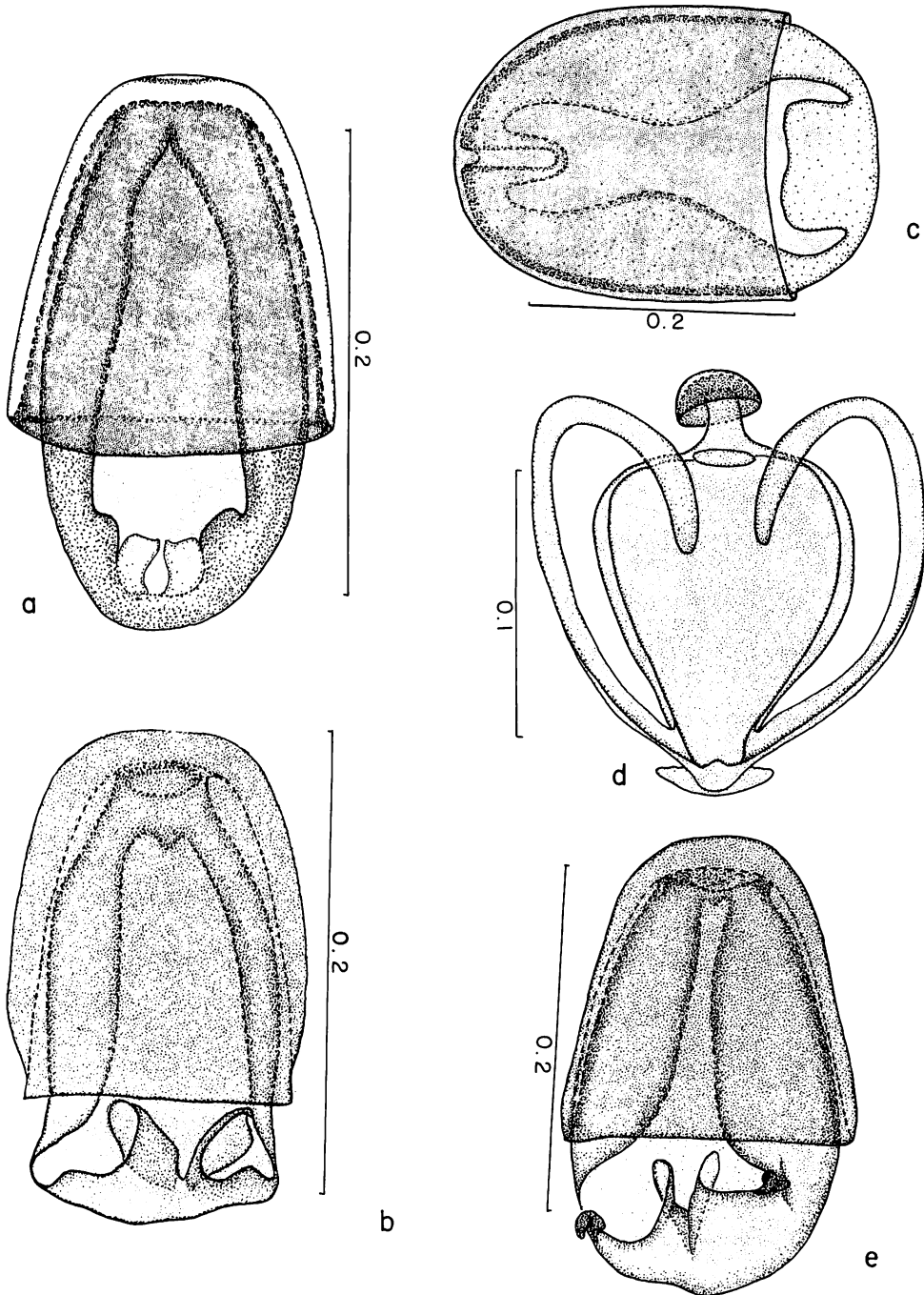


Figure 120—Ventral receptacles: a, *Hecamede persimilis* Hendel; b, *Hostis guamensis* Cresson; c, *Discomyza maculipennis* (Wiedemann); d, *Discocerina mera* Cresson; e, *Paratissa semilutea* (Loew).

sent, face with very fine short hairs which are not stronger above the center . . . mesonotum without long acrostichals; ocellars minute; costa without long outstanding bristles." Wirth (*op. cit.*) further characterized and somewhat modified the concept of the genus and included two new species from the Hawaiian Islands: "Pulvilli underdeveloped, tarsal claws large; face with the facial series of bristles reduced, only the lateral pair strong, if any; facial setulae very short and fine; wings not spotted."

After examining large numbers of additional material of Wirth's two Hawaiian species, including the types, I have found that the pulvilli are as developed as in members of the genus *Neoscatella* Malloch, not at all underdeveloped as stated by Wirth. With the exception of the pulvillus character, I am otherwise following Wirth's generic concept in dealing with the Hawaiian species.

Six species are included under this genus, four of which are endemic to Hawaii. Two are described herein as new species.

The members of this genus can be easily distinguished from the endemic *Neoscatella*, to which they are evidently closely related, by the very short, fine hairs on the face. In addition, *Apulvillus* has reduced facial bristles, sparse and relatively weak mesonotal setulae and bristles, and bare front femora and tibiae (except for *A. femoralis* n.sp. which has the front femora long-haired on the posteroventral surface). The male genitalia and female ventral receptacle are similar to those of *Neoscatella* and *Scatella*.

Species of *Apulvillus* are generally found in fresh water streams. Adults are occasionally swept along with *Neoscatella* spp. from the tops of rocks or boulders in the streams or along the margin. Adults are rarely found in abundance, but are most common near waterfalls, especially at the base where there is a great deal of mist from splashing water. The habits of the adults are very similar to those of *Neoscatella*, particularly those of *warreni* (Cresson).

KEY TO SPECIES OF HAWAIIAN APULVILLUS, ADAPTED FROM WIRTH (1948)

1. Face silvery gray 2
Face brown. 3
- 2(1). Fore femora with numerous long hairs on the post-
flexor surface. Inner verticals as long as outer ver-
ticals; ocellars slightly shorter than inner ver-
ticals. **femoralis** n.sp.
Fore femora practically bare. Inner verticals re-
duced, less than half the length of outer verticals;
ocellars strong. **cinereifacies** n.sp.
- 3(1). Ocellar bristles strong. Presutural dorsocentrals
strong; one pair of moderately strong presutural
acrostichals. **mauiensis** Wirth.
Ocellar bristles weak. Presutural dorsocentrals and
acrostichals weak. **williamsi** Wirth.

***Apulvillus cinereifacies* Tenorio, new species**

Shiny dark brown to black species. Face, genae, prementum, most of the lower portion of thoracic pleura, coxae, and lower margin of abdominal tergites gray. Mesonotal setulae sparse, legs relatively bare. Wings hyaline brown, halteres yellowish.

MALE and FEMALE. *Head:* Face, genae, and prementum gray, frons subshining brown. Antennae dark brown to black with third segment and arista short pubescent; second segment with a fine, long bristle at mid dorsal. Two laterocline orbital bristles, outer verticals and ocellars well developed; inner verticals greatly reduced. Eyes longer than high, slightly more than one-half as high as head. Face with sparse setulae; of the diagonal series of facials, only the lowest two pairs moderately developed; two buccal bristles and a few setulae on each side of median line. Genals present but weak. *Thorax:* Mesonotum and scutellum subshining dark brown. Mesonotal setulae few and scattered. One pair of well-developed postsutural dorsocentrals and one pair of weak acrostichals present at or near the suture. Presutural bristle strong. One pair each of intra-alars and post-alars present; one pair each of apical and lateral scutellars, the latter weak, less than half the length of the former. Two notopleurals, one mesopleural, and one sternopleural developed; posterior notopleural about twice as far dorsad of the notopleural suture as the anterior notopleural. Side of thorax gray, except pteropleura and posterior one-half of mesopleura. Halteres with yellow-brown knobs, brown bases. *Legs:* Coxae and part of femora gray; remainder of legs brown; posterior face of hind femora polished brown. Tibiae and tarsi opaque brown; tarsal claws long; apex of first four tarsomeres with long spine-like bristles ventrally. *Wings:* Hyaline brown, more than twice longer than wide; second costal sector about six times as long as third sector. *Abdomen:* Somewhat opaque brown dorsally, gray ventrally.

Length: body, 2.6 mm.; wings, 3.0 mm.

Holotype male, allotype female, and 11 male/female paratypes: Kauai, Opaekaa Str., April 4, 1970 (M. D. Delfinado, collected on wet rocks; 2 paratypes collected by L. Teramoto and L. Uyenishi). 9 male/female paratypes as follows: Waipoo Falls, April 4, 1970 (M. D. Delfinado, L. Teramoto, and L. Uyenishi, on wet rocks); Honopu, June 17, 1922 (E. H. Bryan, Jr.); Nualolo, June 18, 1922 (E. H. Bryan, Jr.); Kalalau Val. Trail, December 14, 1963 (D. E. Hardy). One additional specimen, not a paratype, with part of abdomen broken, Honopu, June 17, 1922 (E. H. Bryan, Jr.), apparently the same species.

Holotype, allotype, and 6 paratypes to be deposited in the B. P. Bishop Museum; 2 paratypes each to U.S. National Museum and British Museum (Natural History); remainder to University of Hawaii.

Adults of this species were collected in fast-moving streams in association with *Neoscatella cilipes* Wirth, *N. kauaiensis* Wirth, and *N. warreni* (Cresson). While the immature forms of *cinereifacies* are not known, it is very likely that they are found on algae-covered rocks in open-swift stream habitats, probably at the tops of waterfalls.

***Apulvillus femoralis* Tenorio, new species (fig. 115e)**

Similar to *A. cinereifacies* n.sp. in having the face, genae, prementum, sides of thorax, and coxae gray. It is distinguished easily from *cinereifacies* by the hairy front femora (fig. 115e) and relatively strong inner verticals and somewhat weak ocellars. Frons, mesonotum, scutellum, and abdomen opaque brown.

MALE. *Head:* Bristles relatively weak, with the following present: two laterocline orbitals, inner and outer verticals, the ocellars divergent and placed close together, almost between the posterior ocelli, and only one-half to three-fourths as long as the verticals or the orbitals. Ocellar tubercle conspicuously raised. Orbital plates raised higher than eyes, thus appearing like a ledge along the mesal margin of eyes. Frons opaque brown, darker along anterolateral margin, a little more than twice wider than long. Eyes small, slightly more than one-half the height and one-half the length of the head. Face ash gray, broad and extending far in front of eyes, forming a 90° angle with the epistoma; facial hump almost at level of antennal bases and extending cephalad of ptilinal suture about the same distance as the anterior ocellus is from the suture; no distinct diagonal series of facials, facial setulae fine and sparse. Oral margin with fine hairs, longest laterally. Gena same color as face, post-gena becoming matt brown. *Thorax:* Mesonotum, scutellum, and abdomen subshining to opaque brown. Postsutural dorsocentrals, intraalars, postalars, and presuturals relatively well developed; a pair of weak acrostichals at or near the suture; mesonotal setulae few and sparse. Scutellum with a pair of strong apical and a pair of weak lateral scutellars, the latter placed closer to the former than to the scutellar suture. Two notopleurals, one mesopleural, and one weaker sternopleural bristle. Sides of thorax gray, except posterior half of mesopleura and pteropleura. Halteres reddish brown. *Legs:* Coxae gray; femora, tibiae, and tarsi dark brown. Front femora with long bristles along ventral surfaces (fig. 115e). Tarsal claws long, parallel, and relatively straight. *Wings:* Brown, more than twice longer than wide; second costal sector about five times as long as third sector. *Abdomen:* Brown.

Length: Body, 3.8 mm.; wings, 3.8 mm.

FEMALE. Unknown.

Holotype male, Puu Nianiau, Maui, April, 1954 (M. Tamashiro). In the B. P. Bishop Museum.

***Apulvillus mauiensis* Wirth (figs. 115a,c, 123a)**

Apulvillus mauiensis Wirth, 1948, Proc. Haw. ent. Soc. 13:300. Holotype and allotype in B. P. Bishop Museum.

Endemic. Maui (type locality: Haipuaena), Molokai, Hawaii. The latter two islands are new records.

Large, opaque, dark brown to black species. Head and thoracic bristles relatively weak (fig. 115a,c). Ocellars, orbitals, and outer verticals equally developed; inner verticals reduced, about one-third to one-half the length of the

ocellars. Fore femora practically bare. Most specimens with moderately developed acrostichals (one pair at or near the suture) and one pair of presutural dorsocentrals; in some specimens, these bristles are weak. Wings usually hyaline; seven specimens from Kohala Mts., Hawaii, have indications of pale spots on their wings. Female ventral receptacle as in figure 123a.

Adults are generally found in open-swift stream habitats, particularly at the base of waterfalls or where mist is generated by water splashing against boulders in the stream. Large populations of adults were found in Honokane Nui Valley, Hawaii, at the base of a man-made waterfall. Despite such an abundance of adults, however, no immature forms were found in this location. As mentioned above, two pupae were recovered from a stream in Molokai (see discussion under immature section).

***Apulvillus williamsi* Wirth (figs. 115b,d,f)**

Apulvillus williamsi Wirth, 1948, Proc. Haw. ent. Soc. 13:299. Holotype and allotype in the B. P. Bishop Museum.

Endemic. Hawaii (type locality: Akaka Falls).

Similar to *A. mauiensis* in both size and color, *A. williamsi* may be distinguished from *mauiensis*, which has only the inner verticals and sometimes the acrostichals and antesutural dorsocentrals weak, by having the ocellars, inner verticals, antesutural dorsocentrals, and acrostichals always weak.

Large, opaque, dark brown to black species. Bristles generally weak and appearing sparse. Ocellars, inner verticals, acrostichals, and antesutural dorsocentrals reduced, the latter two sometimes as weak as the mesonotal setulae, which are very fine. Fore femora practically bare.

Found only on the island of Hawaii, this species is generally found in open-swift portions of streams. Like *mauiensis*, it usually occurs in situations where water splashes against rocks in swift-moving streams. I have collected specimens from sea level (stream mouth) up to 1000 ft. in elevation. Although *mauiensis* also occurs on the island of Hawaii, I have never collected both species in the same location.

Species collected in association with *A. williamsi* include *Neoscatella warreni*, *N. clavipes*, and *N. cilipes*.

The immature stages of this species are unknown. They are probably found on algae-covered rocks submerged in swift streams. It is likely that the larvae and pupae resemble those of *A. mauiensis*. Two puparia collected from Boiling Pots, Hawaii, are very similar to those of *mauiensis*, but may be this species (refer to the discussion under the section of immatures).

Genus NEOSCATELLA Malloch

Neoscatella Malloch, 1935a, Bull. B. P. Bishop Mus. 114:9; Cresson, 1935, Trans. Am. ent. Soc. 61:359; Wirth, 1948, Proc. Haw. ent. Soc. 13:281.

Type-species, *atra* Malloch, by original designation.

References: Wirth (1948) for taxonomy and Williams (1938) for biological details.

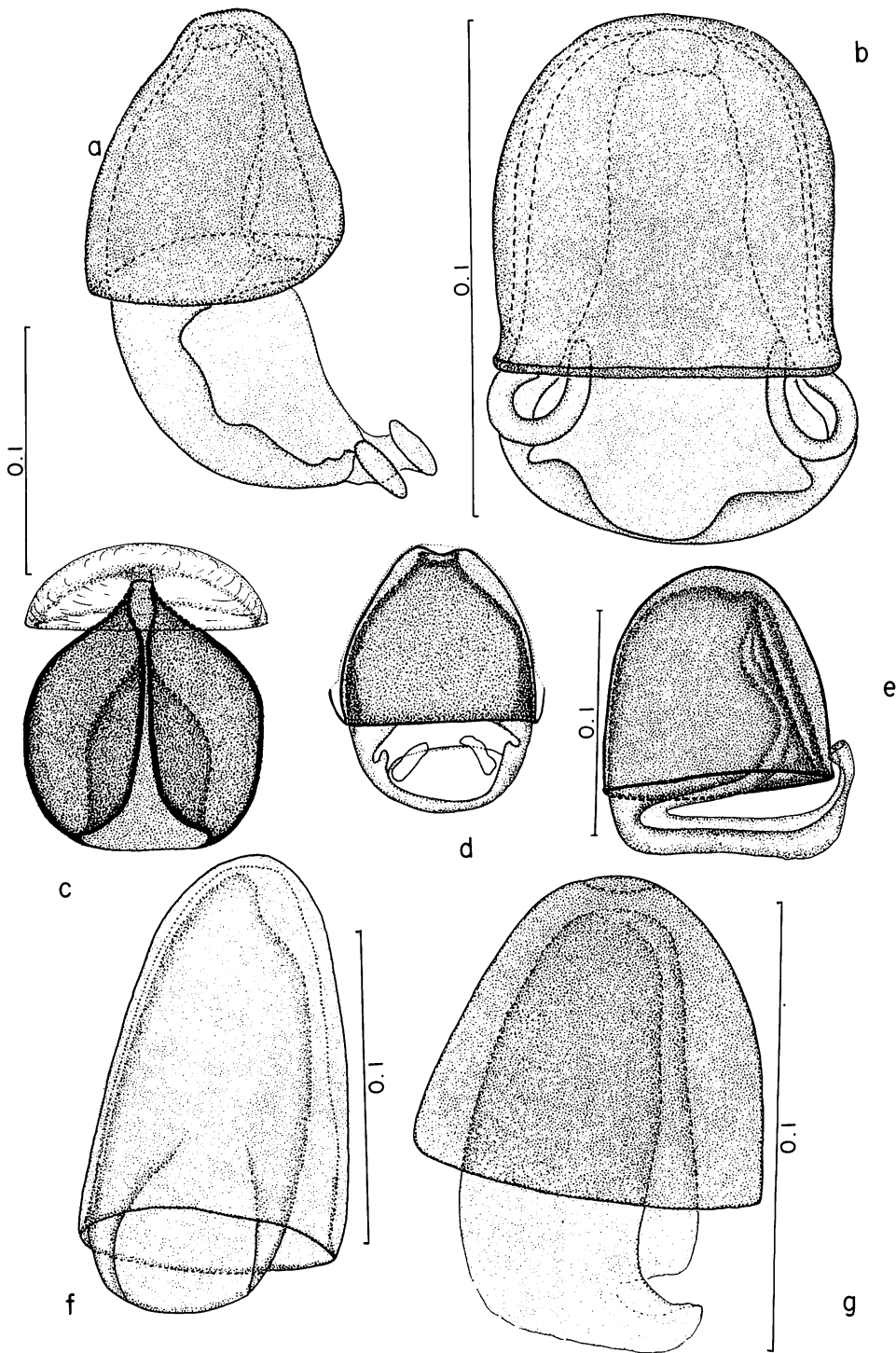


Figure 121—Ventral receptacles: a, *Ceropsilopa coquilletti* Cresson; b, *Notiphila insularis* Grimshaw; c, *Donaceus nigronotatus* Cresson; d, *Clasiopella uncinata* Hendel; e, *Psilopa olga* Cresson; f, *Hydrellia williamsi* Cresson; g, *H. hawaiiensis* Cresson.

The latest revision of this genus was made by Wirth (1948), and I am following Wirth's treatment of the group in this discussion.

Malloch (1935a) proposed the genus *Neoscatella*, separating it from the closely related *Scatella* by the presence of presutural dorsocentral bristles and acrostichals. Cresson (1935) supported Malloch's proposal and transferred the five known Hawaiian *Scatella* to the new genus. In his revision of the genus, Wirth (1948) also transferred *Scatella oahuense* Williams, which had been described in 1938, to *Neoscatella* and described five additional species under this genus. I am herein synonymizing two of Wirth's species and describing two species as new.

This genus is similar to *Scatella* from which it is distinguished primarily by the presence of a pair of presutural dorsocentrals and at least one pair of strong acrostichals at or near the suture.

Morphological characters utilized to separate the species of *Neoscatella* include modifications of the front legs, the number of pale spots and bandings on the wings, reduction of the inner vertical bristles, and general coloration.

Neoscatella contains the largest number of ephydrid species in the Hawaiian Islands: 11 species now known from Hawaii, including two new species described herein. All of these, with the exception of *N. sexnotata* which is also found on Wake Island (Micronesia), are apparently endemic to the Hawaiian Islands.

All of the Hawaiian *Neoscatella* are associated with water. Two species are found generally along the sea coasts, on beach sand, in rock pools, and on banks of estuaries and canals. Two or three other species are relatively common in standing water in low-land areas. The great majority of the *Neoscatella*, however, are found most commonly in streams and other bodies of water in the valleys and mountains. Some of these species show preference for higher elevations, some predominate at lower elevations, and still others thrive equally well in either high or low areas, provided suitable water habitats are available. Low-land species are usually associated with stagnant or polluted water, while forest and upland species are restricted to clear, clean stream water.

Interestingly enough, the two rather distinct types of habitats, calm or standing water versus flowing streams, may be correlated with two morphologically defined groups of larvae within the *Neoscatella*: those bearing palmate hairs on the apex of the posterior spiracular tubes and those with strong spines on the apex of the spiracular tubes. These distinctions are discussed in more detail in the section on immatures below.

KEY TO SPECIES OF HAWAIIAN NEOSCATELLA, MODIFIED FROM WIRTH (1948)

1. Wings with pale spots, sometimes very faint. 2
- Wings without pale spots, sometimes with an irregular subapical dark band. 9

- 2(1). Wings with indications of, at most, two pale spots. 3
 Wings with more than two pale spots. 5
- 3(2). Inner verticals greatly reduced, half or less than half
 the length of outer verticals. **oahuense** (Williams).
 Inner verticals well developed, about half in length
 to the outer verticals. 4
- 4(3). Small, opaque, dark brown species with mesonotal
 setulae underdeveloped; anterior intraalars about
 twice as long as either the posterior intraalars or
 the supraalars. **fluvialis** n.sp.
 Medium to large, somewhat shiny dark brown to
 black species with mesonotal setulae usually well
 developed; anterior intraalars as long as the
 posterior intraalars and the supraalars.
 **warreni** (Cresson).
- 5(2). Wings with six or, sometimes, eight pale spots 6
 Wings with five spots or less. 7
- 6(5). Shiny brown to black species. Mesonotum with one
 presutural and two postsutural dorsocentrals; on-
 ly the presutural acrostichals present; mesonotal
 setulae not well developed. Post-flexor bristles of
 fore femora about as long as diameter of femur.
 Wings usually with eight pale spots, including
 two at the apices. **bryani** (Cresson).
 Opaque brown species. Mesonotum with one
 presutural and three postsutural dorsocentrals;
 one presutural and one postsutural acrostichal;
 mesonotal setulae prominent. Post-flexor bristles
 of fore femora twice as long as diameter of femur.
 Wings without two apical spots.
 **sexnotata** (Cresson).
- 7(5). Inner verticals greatly reduced. Wing spots varying
 from three to five. **oahuense** (Williams).
 Inner verticals well developed. Wing spots distinctly
 five in number. 8
- 8(7). Color opaque, brownish olive. **terryi** (Cresson).
 Color shiny dark brown to black above, pollinose
 toward sides. **hawaiiensis** (Grimshaw).
- 9(1). Fore tarsi of male enlarged, sometimes compact and
 club-shaped. Female cerci with a short cone-
 shaped seta anteriorly (fig. 116d). **clavipes** Wirth.
 Fore tarsi of male not as above. Female cerci with a
 long curved seta (fig. 110a). 10

- 10(9). Wings with an irregular subapical dark band, sometimes with indications of two pale spots. **kauaiensis** Wirth.
Wings without an irregular subapical dark band. 11
- 11(10). Male with post-flexor bristles of fore femora more than twice as long as diameter of femur; apex of tibia with several long, fine hairs; tarsi with abundant long wavy hairs dorsally. Female fore femora with fine, widely-spaced but long, post-flexors. **cilipes** Wirth.
Male fore femora and tarsi not as above. Female with post-flexors short and closely placed, not fine and sparse. 12
- 12(11). Fore legs (fig. 116c) with tarsi about four-fifths the length of tibia and with erect, fine, sparse setae dorsally; fore femora with post-flexors scarcely three-fourths the diameter of femur. In general, bristles and setulae sparse. Small, opaque species. **amnica** n.sp.
Fore legs with tarsi longer than the tibia and with dense erect setae dorsally (fig. 118d); fore femora with post-flexors longer than diameter of femur. Bristles and setulae prominent. Small to large, somewhat shiny species. **warreni** (Cresson).

Neoscatella amnica Tenorio, **new species** (figs. 116b, c, 124a)

Small, opaque brown species with dark unspotted wings. Vertical, ocellar, and fronto-orbital bristles subequal, genal bristles weak. Intraalars and supraalars reduced to fine hairs. Fore legs with post-flexors of femora scarcely longer than three-fourths the diameter of the femur; tarsal length four-fifths that of the tibia (fig. 116c).

MALE and FEMALE. *Head:* Frons subshining, dark brown beneath brown pollinosity. Ocellars, verticals, and fronto-orbitals well developed. Antenna black; second segment with conspicuous bristles apically on the ventral and mesal margins; third segment scarcely longer than broad, with short, white pubescence; arista about twice as long as third segment, bare ventrally and short pubescent dorsally to three-fourths its length, the pubescence progressively sparse toward the apex. Facial hump prominent; face concave at area below the antenna and between the eyes and facial hump. Five pairs of moderately developed facials in a diagonal series, the facial closest to the oral margin longest, about one-third again as long as the one dorsal to it. Oral margin with a row of four to five bristles, weaker than the facials, except the lateral-most which is as long as the longest facial. Genal weak, about one-half to two-thirds the length of the longest facials. *Thorax:* Mesonotum and

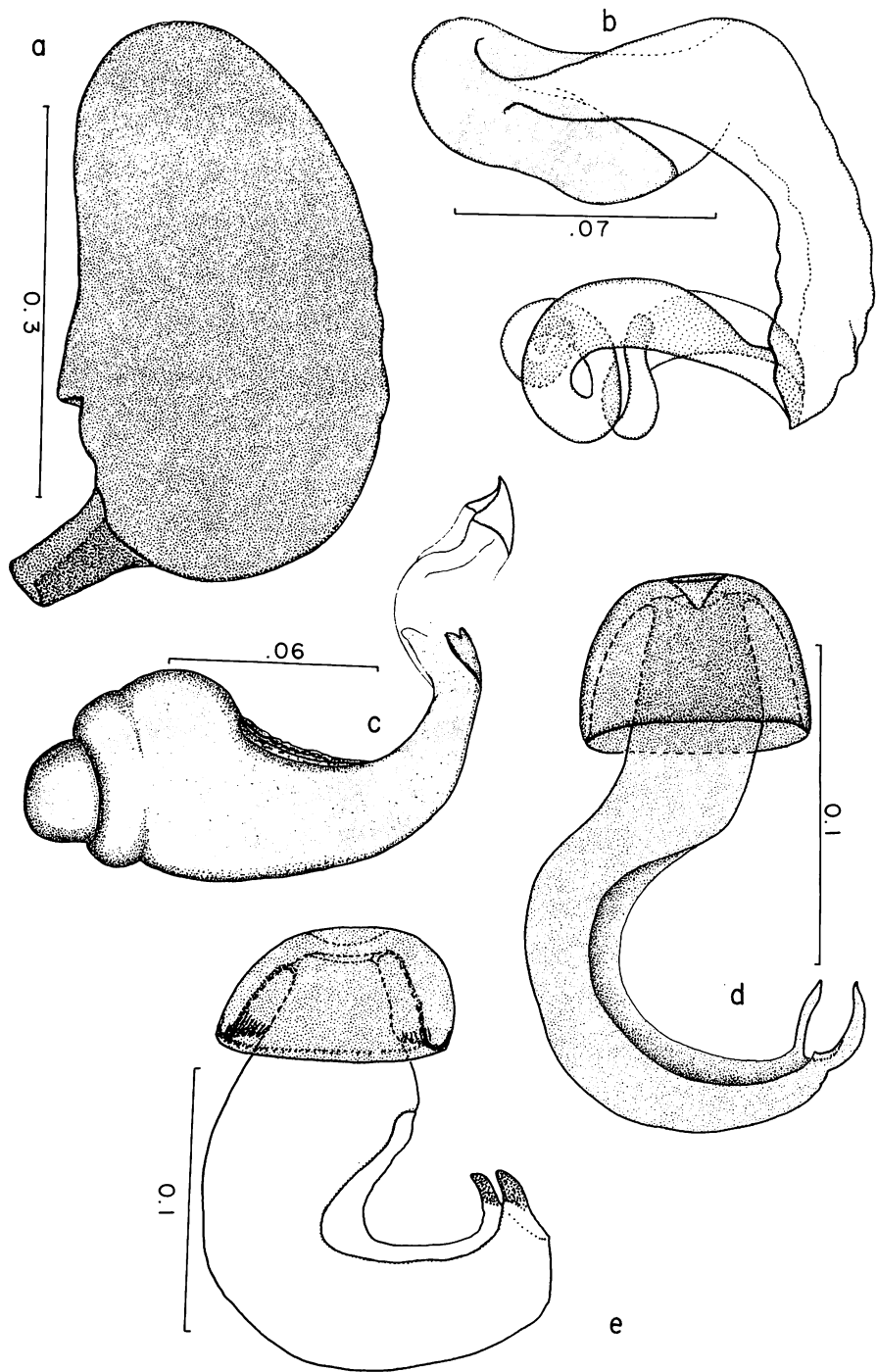


Figure 122—Ventral receptacles: a, *Brachydeutera hebes* Cresson; b, *Lytogaster gravida* (Loew); c, *Hyadina vitifacies* Tenorio, n. sp.; d, *Ephydra milbrae* Jones; e, *E. cinerea* Jones.

scutellum pollinose brown, somewhat subshining when viewed dorsally. One pair of acrostichals at or slightly in front of the transverse suture; one pair of presutural and two pairs of postsutural dorsocentrals. Two pairs of intraalars and one pair of supraalars present, all weak, about one-third to one-half the length of the presutural bristle (fig. 116b). Two pairs of scutellars, the lateral pair about one-third the length of the apical pair and approximately half way between the apical scutellars and the scutellar suture. Halteres yellow. *Wings*: Brown, two and one-half times longer than wide. *Legs*: Fore femora with four or five post-flexor bristles irregular in length, the longest scarcely as long as three-fourths the diameter of the femur. Fore tarsi relatively short, four-fifths as long as the tibia; apex of tarsomeres with conspicuous stout black bristles on posteroventral surface. *Abdomen*: Darker brown than mesonotum and scutellum. Cerci of female with a curved, spine-like bristle anteroventrally, as in most other *Neoscatella*. Female ventral receptacle as in figure 124a.

Length: body, 1.7 mm.; wings, 1.9 mm.

Holotype male, allotype female, and 36 male/female paratypes: Hawaii, Wailuku River, 2170 ft., August 14, 1970 (J. A. Tenorio). 111 additional paratypes as follows: Molokai: Waiahanau Val., November 17, 1964 (D. E. Hardy); Halawa Val., July, 1952 (D. E. Hardy). Maui: 5 mi. E. Kaeleku, April 8, 1965 (T. W. Fisher); Kopiliula Str., 1200 ft., September 4, 1970 (J. A. Tenorio); Wailua, July, 1953 (D. E. Hardy); Kipahulu Val., February 21, 1970 (D. E. Hardy); Waikamoi, 4000 ft., July, 1956 (R. Namba, D. E. Hardy); Kula Pipe Line, 4200 ft., July, 1958 (R. Namba). Hawaii: Akaka Falls, Hilo, March, 1946 (W. W. Wirth); Boiling Pots, May 28, 1970 (J. A. Tenorio); Rainbow Falls, May 28, 1970 (J. A. Tenorio); Akaka Falls St. Park, May 28, 1970 (J. A. Tenorio); Kawainui Str., May 28, 1970 (J. A. Tenorio); Piihonua, Wailuku Str., December 27, 1969 (J. A. Tenorio); Akaka Falls, April 19, 1964 (D. E. Hardy); Paaui, August, 1952 (W. C. Mitchell).

Holotype, allotype, and 10 paratypes in Bishop Museum; 10 paratypes deposited in the U.S. National Museum; 6 in the British Museum (Natural History); and the remaining 85 paratypes in the University of Hawaii collection.

In size and overall coloration, this species resembles at least five other endemic *Neoscatella*, including *N. cilipes*, *N. clavipes*, *N. oahuense* (small form), and *N. fluvialis* n.sp. The male of *amnica* differs from the male of *clavipes* and *cilipes* by lacking modifications on the front legs, from *oahuense* by having well-developed inner verticals, and from *fluvialis* by having reduced anterior intraalars. Some difficulty may be encountered in distinguishing the female of *amnica* from those of the species mentioned above. Generally, *amnica* females differ from those of *cilipes* in lacking long post-flexors on the fore femora; from *clavipes* in having a long curved seta on the cercus instead of a stubby cone-shaped seta; and from *oahuense* and *fluvialis* by the same characters which distinguish the males. The female of *N. warreni* also resembles *amnica* superficially. However, *warreni* is larger than *amnica* and has well-developed intraalars and supraalars, unlike *amnica* in which these bristles are weak.

Immature forms of this species have been collected from Kopiliula Stream on Maui. Several females were reared from larvae. Both the larvae and puparia resemble those of *clavipes* and *cilipes*, and I have not been able to find any distinguishing characters to separate the immature forms of these three species. *N. amnica* adults are found on moist rocks in and along the margins of open-swift, open-slow, and closed-swift stream habitats. They have been observed feeding on the algae by continually lapping the surface of algae-covered rocks with their proboscis.

***Neoscatella bryani* (Cresson)**

Scatella bryani Cresson, 1926, Proc. Haw. ent. Soc. 6:276. Holotype male in B. P. Bishop Museum.

Neoscatella bryani (Cresson), 1935, Trans. Am. ent. Soc. 61:360; Wirth, 1948; Proc. Haw. ent. Soc. 13:291.

Endemic. Kauai (type locality: Awaawapuhi), Oahu, Molokai, Lanai, Maui, and Hawaii.

Similar to *N. sexnotata* in having six distinct white spots on wings. However, *bryani* is smaller, darker brown, shinier, and has less well-developed bristles and setulae, particularly on the mesonotum. In addition to the six distinct spots, two faint spots are present at the wing apex. Williams indicated these apical spots in his figure of the wing of *bryani* (1938, pl. V, fig. 25). Wirth (1948:291-292) considered these spots as atypical of the species. I have examined in excess of 200 specimens and most, if not all, possess these apical wing spots, although they may sometimes be faint. I consider these spots characteristic of *bryani*.

Williams (1938) presented biological notes on this species and mentioned that it is generally found in low-land areas, particularly where there is standing water. Wirth (1948) added that *bryani* may invade higher altitudes and running streams. My own observations support both of these findings. In open-slow streams, as well as in standing water situations, *bryani* is restricted to the muddy banks or marginal pools where the water is calm. Larvae may be found in algae on the rocks or on the muddy banks.

Populations from higher altitudes and margins of slow streams appear to be different from those of the low-lands. The latter populations are generally smaller and lighter brown; the background color of their wings is lighter, thus making the pale wing spots less distinct. On the other hand, the wings of the high-land stream individuals are darker and the pale spots, including the two apical spots, show up more distinctly.

Larvae and pupae appear identical to those of *N. hawaiiensis* and *Scatella stagnalis*, which also occupy similar habitats in the low-lands. For larval characters, refer to the section on immatures under *hawaiiensis*.

***Neoscatella cilipes* Wirth (fig. 133a)**

Neoscatella cilipes Wirth, 1948, Proc. Haw. ent. Soc. 13:288. Holotype and allotype in the B. P. Bishop Museum.

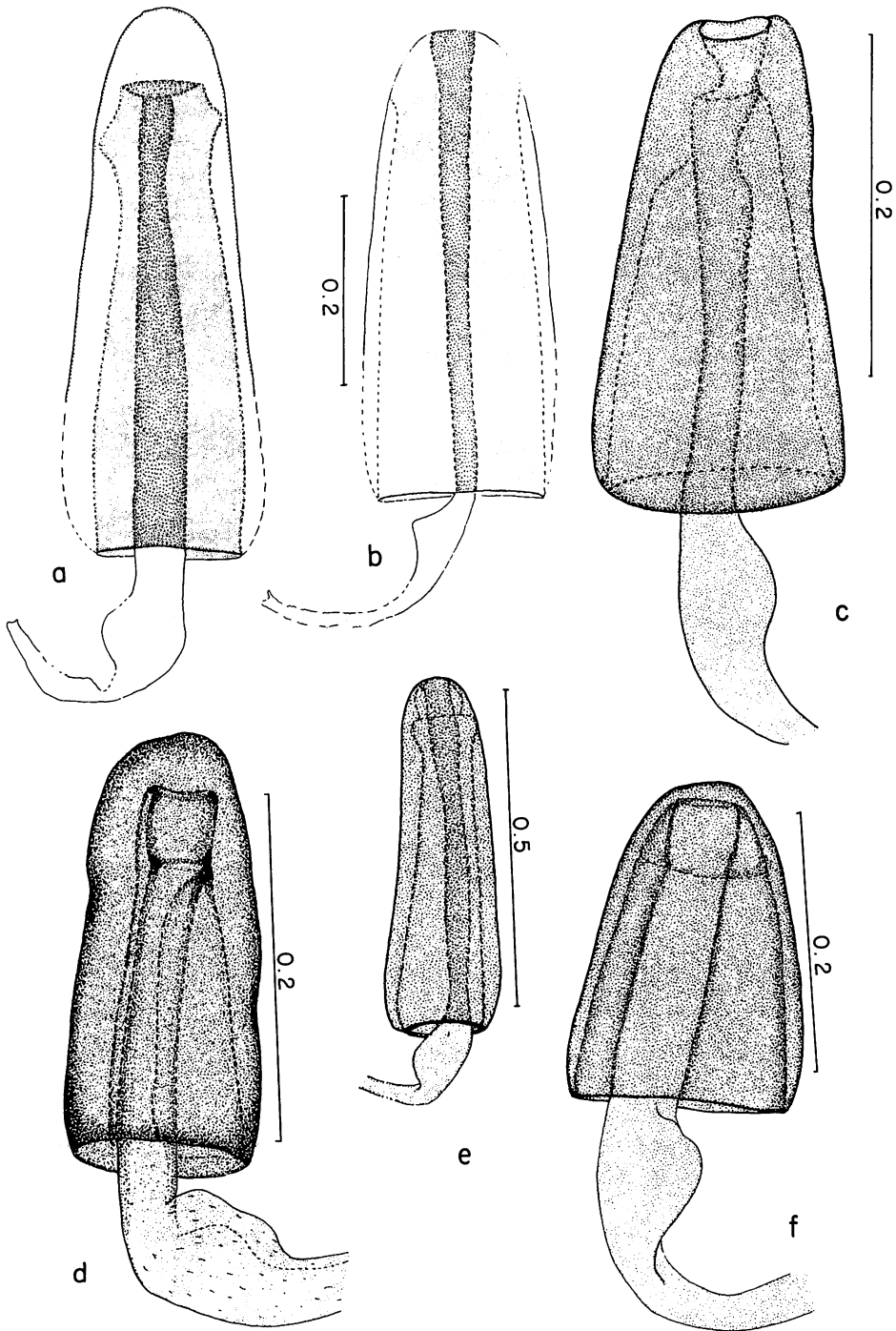


Figure 123—Ventral receptacles: a, *Apulvillus mauiensis* Wirth; b, *A. williamsi* Wirth; c, *Neoscatella clavipes* Wirth; d, *N. sexnotata* (Cresson); e, *N. hawaiiensis* (Grimshaw); f, *N. fluvialis* Tenorio, n. sp.

Endemic. Oahu (type locality: Mt. Kaala), Kauai, Molokai, Maui, and Hawaii. The last three islands constitute new distribution records.

This is a small species similar to *N. clavipes*, *N. amnica* n.sp., and *N. fluvialis* n.sp. The male is easily distinguished from the above species by the long curved bristles on the front legs. The female is more difficult to separate; from *clavipes*, it is differentiated by having a long curved seta on each cercus, this seta short in *clavipes*; from *amnica* and *fluvialis*, or from *clavipes* if the cerci are obstructed, it differs in having long, fine, hair-like bristles on the post-flexor surface of the front femur; these bristles are not very prominent and it takes close examination to see them. For a detailed description of this species, refer to Wirth (1948:288).

This species is found in generally the same habitat as *N. clavipes*, although they are not commonly found together. In streams where *cilipes* is abundant, *clavipes* is either not present or rare. The opposite is usually true in streams where *clavipes* occurs in large numbers. On the island of Maui, for example, I have observed literally thousands of *cilipes* adults in a stream at Waikamoi, and over 200 specimens of this species are preserved from that location in the University of Hawaii collection. However, no *clavipes* has ever been collected from Waikamoi. In Iao Valley, *clavipes* is extremely abundant, while *cilipes* has never been collected. In the Kohala Mts. and Hamakua Coast Streams, both species are present, but *clavipes* seems to predominate. On Kauai, *cilipes* is very common in streams, while *clavipes* is extremely rare, only two specimens recovered from that island. On Oahu, both species may be present in the same stream, although in Kahana Valley streams, *clavipes* seems to predominate.

The habits of *cilipes* are essentially the same as *clavipes* (see under *clavipes*). Eggs are laid in algal mats on rocks in open-swift and closed-swift streams. The larva feeds and pupates within the algal mat. Details of larval and pupal characters are discussed under the section on immatures.

***Neoscatella clavipes* Wirth (figs. 116d-e, 123c)**

Neoscatella clavipes clavipes Wirth, 1948, Proc. Haw. ent. Soc. 13:289.

Holotype and allotype in the B. P. Bishop Museum.

Neoscatella clavipes tenda Wirth, 1948, Proc. Haw. ent. Soc. 13:290. **New synonymy.**

Endemic. Hawaii (type locality: Akaka Falls), Oahu, Kauai, Molokai, and Maui. The last three islands are new records.

Based on the original series of the concurrently described subspecies, *clavipes clavipes* and *clavipes tenda*, their populations did not appear to overlap: the type locality of *clavipes* is Akaka Falls, Hawaii, and that of *tenda* is Kaluanui Val., Oahu. Through the courtesy of Setsuko Nakata of the Bishop Museum, I have examined the types of both of Wirth's subspecies and a long series of specimens from all islands except Lanai. It is now evident that both subspecies occur in the same locality.

Wirth (1948) differentiated *tenda* from the typical *clavipes* principally by *tenda*

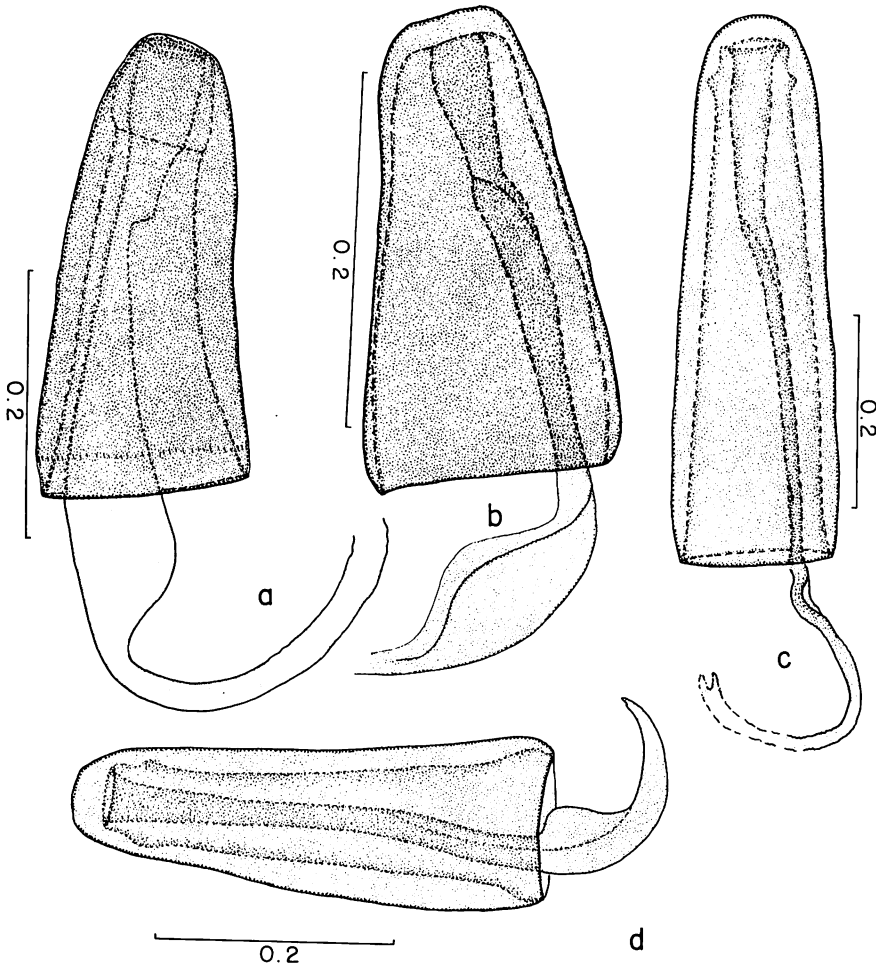


Figure 124—Ventral receptacles: a, *Neoscatella amnica* Tenorio, n. sp.; b, *N. warreni* (Cresson); c, *Scatella wirthi* Tenorio, n. sp.; d, *S. stagnalis* (Fallén).

having longer inner verticals, nearly as long as the outer verticals; longer fore tarsi on the male, about three-fourths the length of the tibiae; and more distinct tarsal claws than *clavipes*. I have found that the characters which Wirth used to differentiate the two subspecies are merely extremes of a wide range of variation occurring within the population of one species. The best examples of this are the populations in Kahana Stream, Oahu. In that location, there were present males with inner verticals varying from less than one-half to about equal the length of the outer verticals and with the front tarsi varying from less than one-half to about three-fourths the length of the tibiae. The length of the front tarsi and amount of exposure of the tarsal claws are evidently determined by the degree of contraction of the tarsi at the time of death. In specimens

where the tarsi appear shortened and the claws atrophied, the apical tarsomeres are curled under, causing the claws to be hidden from view and the tarsi to appear shortened and clubbed. The claws in these cases can easily be seen if the front legs are cleared and mounted on a microscope slide for examination.

In view of these observations, I am hereby synonymizing *tenda* with the typical *clavipes*.

The distinguishing features of the male of this species are the enlarged front tarsi and the front femora usually swollen and almost bare, without post-flexor bristles. In the female, the cerci each bear a stubby, short, and cone-like seta (fig. 116d). This is different from all other Hawaiian *Neoscatella* females, which have this seta on the cercus relatively long, curved, and spine-like (fig. 110a).

This species is found most commonly in open-swift and, occasionally, in closed-swift stream habitats. The adults congregate in large numbers on algae-covered rocks just above the level of rushing water. Eggs are laid in the moist algae, and the larvae feed within the algal mat both above and below the water line. The body spines and posterior tracheal hooks of the larva serve to anchor the larva onto the algae as it forages for food. These structures also help prevent the larva from being washed off its substrate by rushing and splashing water. Pupation takes place within the algal mat, when thick, or in crevices in the rocks.

While this species is apparently restricted to swift streams, it seems to tolerate variations in elevations. In the Wailuku River on Hawaii, I have collected large numbers of specimens at various elevations ranging from 4000 ft. down to sea level at the river mouth. Extremely large populations were encountered in several streams in Hawaii, Maui, and Oahu.

Refer to the section on immatures for descriptions of larvae and pupae, which are very similar to those of *cilipes*.

See discussion under *cilipes* for relationships with that species.

***Neoscatella fluvialis* Tenorio, new species (figs. 116a, 123f)**

Small, opaque dark brown species with dark, two-spotted wings. Mesonotum with anterior intraalars well developed, more than twice as long as the posterior intraalars and the supraalar. Head with inner verticals well developed. Post-flexors of fore femora about as long as, or slightly longer than, the diameter of the femur.

Similar to the small, two-spotted wing form of *N. oahuense*, but differing in having well-developed inner verticals and anterior intraalars. Similar also to *N. amnica* in size and coloration, but differing in having two spots on the wing rather than none.

MALE and FEMALE. Head: Frons and face pollinose brown, the frons darker brown and somewhat subshining. Fronto-orbital, vertical, and ocellar bristles all well developed. Diagonal series of facials relatively well developed, four to five in number; lowest two facials longest of the series and laterodorsally

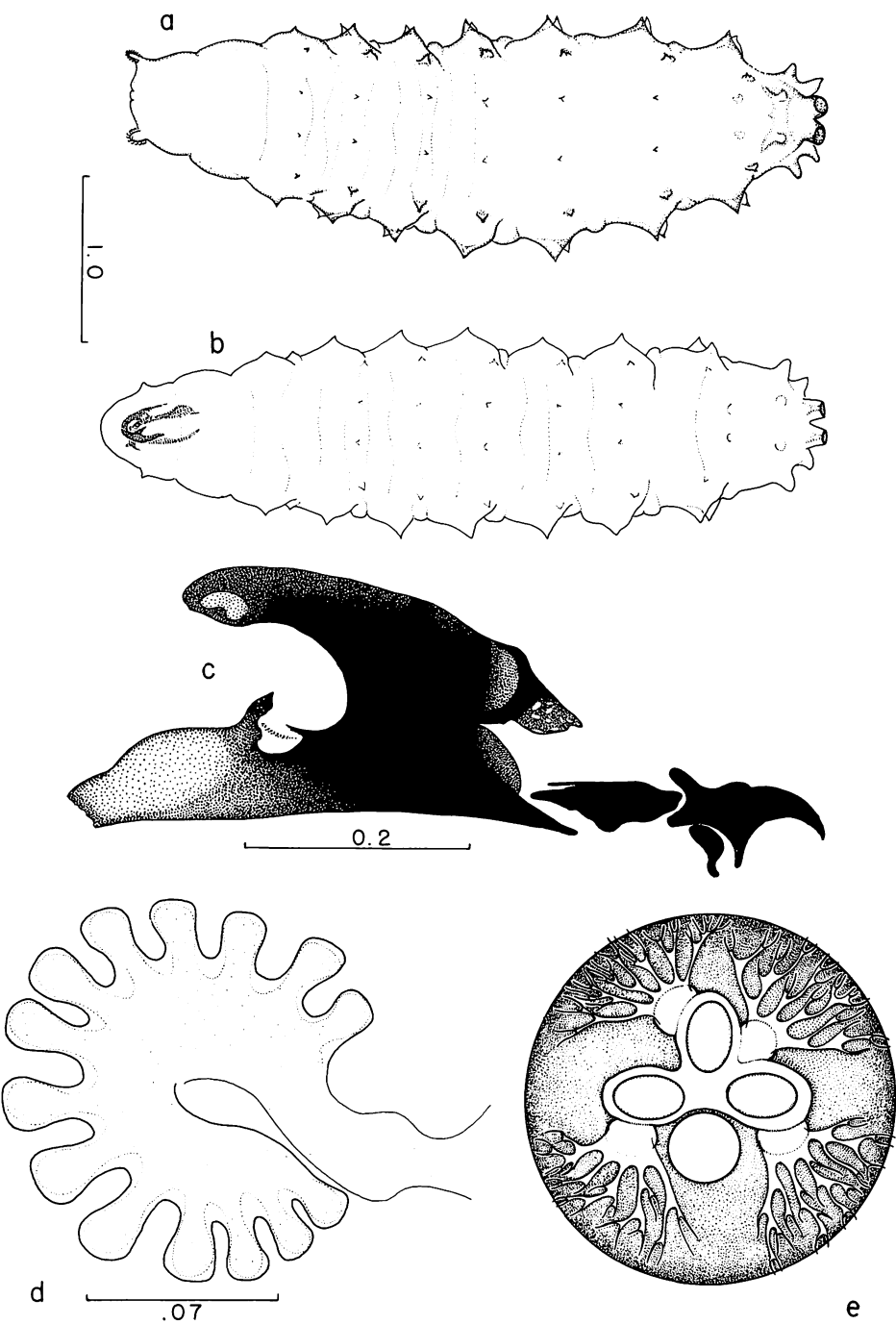


Figure 125—*Placopsidella cynocephala* Kertész: a, pupa, dorsal; b, larva, dorsal; c, cephalopharyngeal skeleton; d, anterior spiracle (pupa); e, posterior spiracle, apical (larva).

directed. Mesofacial setulae short, but stout. Oral margin with five moderately developed bristles on each side, the lateral-most longest. Gena gradually becoming darker grayish-brown posteriorly; one strong genal bristle and several fine hairs present caudad of the genal. *Thorax*: Mesonotum and scutellum somewhat subshining, concolorous with face. One pair of strong acrostichals present at or slightly anterior to the suture; one pair of presutural and two pairs of postsutural dorsocentrals developed. One well-developed presutural bristle close to the notopleuron and more or less aligned with the presutural dorsocentral and the anterior notopleural. Two intraalars and one supraalar present; anterior intraalar strong, about twice as long as posterior intraalar and the supraalar. Two pairs of scutellars, the apical pair more than three times as long as the lateral pair which is half-way between the scutellar suture and the apical scutellar. Two notopleurals, the posterior slightly shorter than and twice as removed dorsad from the notopleural suture as the anterior notopleural. Mesopleura and sternopleural each with one strong bristle. Sides of thorax grayish, except the posterodorsal half of mesopleura which is pollinose brown and hairy. Halteres yellow. *Legs*: Mostly grayish. Fore femora with a row of six to seven post-flexor bristles progressively longer toward middle, the longest about as long as diameter of femur. Front tarsi of male as long as, or longer than, the tibia; apex of fourth tarsomere of front tarsi with a pair of strong setae ventrally. *Wings*: Dark brown, about two and one-half times longer than wide; two white spots, one in cell R_3 half-way between the r-m crossvein and apex of vein $R_4 + 5$, the other in cell R_5 , half-way between the cu crossvein and apex of $M_1 + 2$. *Abdomen*: Opaque grayish brown, darker than mesonotum and scutellum. Female cerci anteroventrally with a curved spine-like bristle directed posteriorly. Female ventral receptacle as in figure 123f.

Length: Male, body, 2.0 mm.; wings, 1.9 mm. Female, body, 2.5 mm.; wings, 2.4 mm.

Holotype male, allotype female, Hawaii, Wailuku R., 2170 ft., August 14, 1970 (J. A. Tenorio). 52 male/female paratypes as follows. Oahu: Kahana Str., 180 ft., August 27, 1970 (J. A. Tenorio). Hawaii: same data as type; Wailuku R., 2170 ft., August 14, 1970 (D. E. Hardy); Wailuku R., 1000 ft., August 14, 1970 (J. A. Tenorio).

Holotype, allotype, and 10 paratypes in B. P. Bishop Museum; 6 paratypes in British Museum (Natural History); 6 paratypes in U.S. National Museum; and 30 paratypes in University of Hawaii.

The name *fluvialis* comes from the Latin "of the stream." This species is found in open-swift streams with water flowing over algae-covered rocks and boulders. Larvae and pupae are collected from the same site where adults were feeding, but these are identical to those of *clavipes*, *cilipes*, and *amnica*, and no definite correlation with adults of *fluvialis* was made.

***Neoscatella hawaiiensis* (Grimshaw) (fig. 123e)**

Scatella hawaiiensis Grimshaw, 1901, Fauna Hawaiiensis. 3:49; Williams, 1938, Proc. Haw. ent. Soc. 10:104.

Neoscatella hawaiiensis, Cresson, 1935, Trans. Am. ent. Soc. 61:360; Wirth, 1948, Proc. Haw. ent. Soc. 13:294.

Endemic. Oahu (type locality: Mt. Kaala), Kauai, Molokai, Lanai, Maui, and Hawaii. Specimens from Lanai constitute a new island record.

This species is medium in size, shiny dark brown to black, with well-developed inner and outer verticals, and with five pale spots on the wings. The wing veins distinctly undulate in the region of the wing spots.

Two other Hawaiian *Neoscatella*—*terryi* and *oahuense*—resemble *hawaiiensis* in having five pale spots on the wings. The shiny, dark brown to black *hawaiiensis* differs primarily in coloration from the brownish-olive *terryi*, and is distinguished from *oahuense* by its well-developed inner verticals (reduced in *oahuense*). Female ventral receptacle as in figure 123e.

This species is widespread and occupies a wide range of aquatic habitats. It is particularly common along margins of pools and pond, on wet banks, and on the muddy margins of slow-moving streams. Adults and larvae feed on algae and microorganisms on rocks and wet soils. As Williams (1938:104) observed, the larva has four groups of palmate hairs on the posterior spiracular tubes. These hairs spread out over the surface of the water when the larva is feeding in liquid medium.

N. hawaiiensis is found in the low-lands, as well as in valleys and mountains along margins of open-slow and closed-slow streams. Like *bryani*, the low-land populations appear to have individuals with lighter wings, while those in the mountains and valleys have darker wings. On Hawaii and Oahu, this species is equally common in high and low elevations. On Maui, it is generally found at high elevations, one specimen from that island collected as high as 10,000 feet in elevation (Kolekole Peak).

***Neoscatella kauaiensis* Wirth**

Neoscatella kauaiensis Wirth, 1948, Proc. Haw. ent. Soc. 13:282. Holotype and allotype in B. P. Bishop Museum.

Endemic. Kauai (type locality: Kokee).

Medium to large, shiny brownish black species with an irregular subapical dark band on the wings; bristles and setulae moderately developed; one pair of presutural and two pairs of postsutural dorsocentrals; and one pair each of presutural and postsutural acrostichals.

The *kauaiensis* wing sometimes has indications of two pale spots, one each in cells R_3 and R_5 , similar to the two pale spots in the same locations on the wings of *warreni*; however, *warreni* never has the subapical dark wing band found in *kauaiensis*.

Wirth (1948:284) pointed out the resemblance of *kauaiensis* to a New Zealand species, *Scatella nubeculosa* Tonnoir, which also has a dark band on the wing. However, as Wirth further mentioned, *S. nubeculosa* is smaller, has the wing band extending to the apex, the face yellowish brown, and traces of pale vittae on the mesonotum.

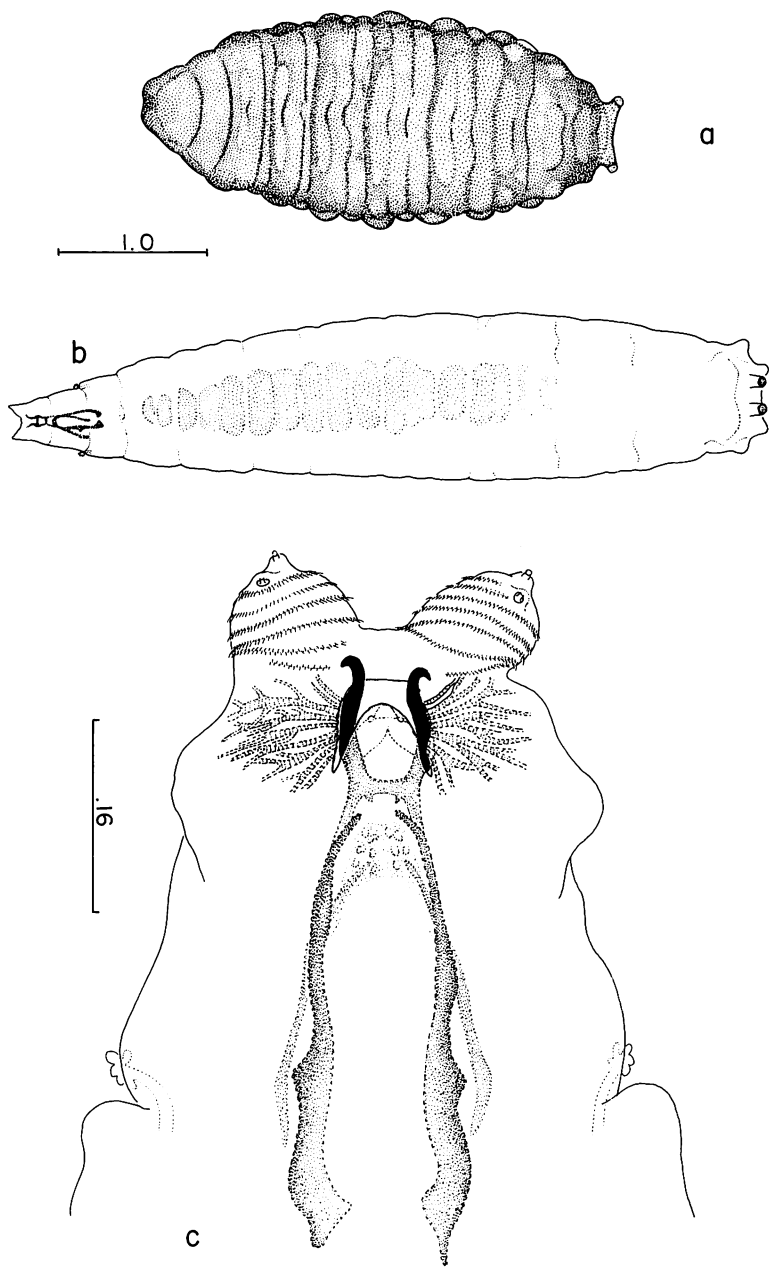


Figure 126—*Hecamede persimilis* Hendel: a, pupa, dorsal; b, larva, dorsal; c, larva, anterior end.

While it is apparently very widely distributed and successful on Kauai, *kauaiensis* has not yet been found on any of the other islands. On Kauai, it is found most abundantly along the margins of open-swift stream habitats on algae-covered rocks. It is also found on rocks in open-slow stream habitats. Large numbers of pupae were observed and some collected floating in water among plant debris in a pool at the base of Waipoo Falls. In the same location, adults were extremely numerous on rocks and boulders in and along the pool margin (M. D. Delfinado, pers. comm.). John Kjargaard, a student in the College of Tropical Agriculture at the University of Hawaii, observed large populations of these flies in a stream at Kalalau Valley.

Among 20 or more pupae collected at Waipoo Falls, only one larva was found. Some of the puparia contained mature pupae which were dissected and found to contain preadults of *kauaiensis*. Since the single larva among the pupae was identical in all respects, except for degree of sclerotization, to the puparia of *kauaiensis*, it was presumed to be a larva of that species. The larva and pupae are discussed in the section on immatures.

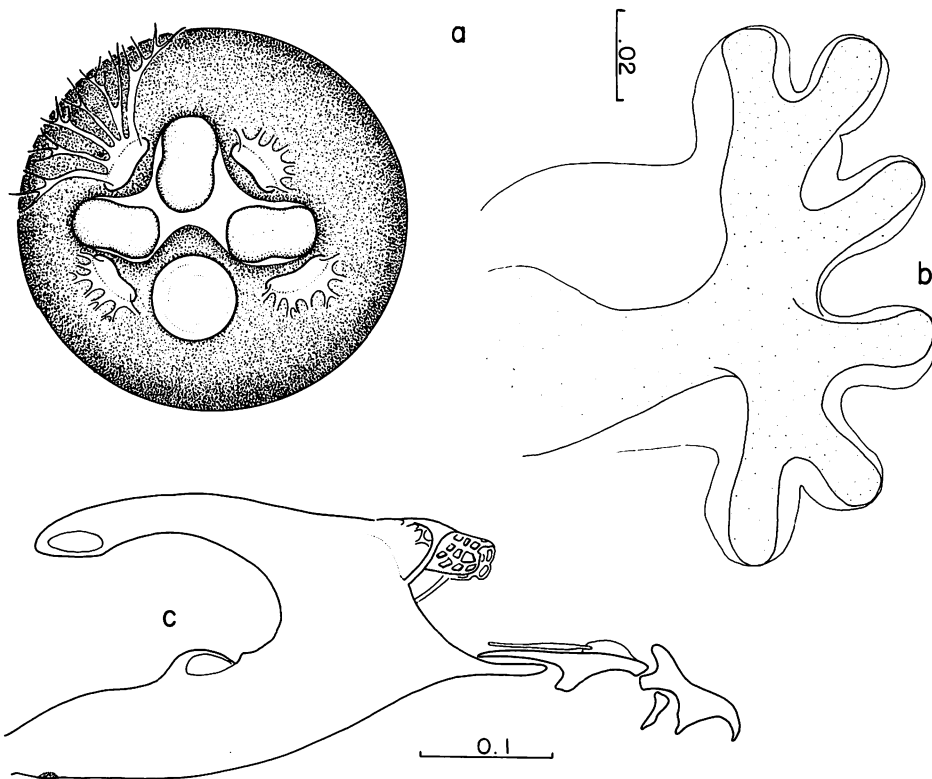


Figure 127—*Hecamede persimilis* Hendel: a, posterior spiracle, apical (larva); b, anterior spiracle (larva); c, cephalopharyngeal skeleton.

Neoscatella oahuense (Williams) (fig. 117)

Scatella oahuense Williams, 1938, Proc. Haw. ent. Soc. 10:107. Holotype and allotype in B. P. Bishop Museum.

Neoscatella oahuense, Wirth, 1948, Proc. Haw. ent. Soc. 13:295.

Endemic. Oahu (type locality: Hering Val., Tantalus), Maui, Hawaii.

Small to medium-sized species, somewhat opaque brown to shining black in color, having the following distinguishing characteristics: head with inner vertical bristles greatly reduced; wings with variable numbers of pale spots ranging from two to five, the latter being the most common in large specimens. The wing spot in cell R_5 and the more apical one in cell M_2 are always present and usually distinct. Other spots are usually either very faint or completely absent (see figs. 117a-d for wing variation).

The larger specimens with five spots on the wings resemble *N. hawaiiensis* and *N. terryi*, but may be distinguished from them by having the inner verticals reduced rather than well developed, as in the above-mentioned species. The smaller-sized *oahuense* is similar to *N. fluvialis* n.sp., but can be separated from this species, again, by the reduced inner verticals.

According to Williams (1938), the habitat of this species corresponds to that of *hawaiiensis*. From my own observations, this species is more restricted to open-slow stream habitats or their wet banks and small puddles of water in valleys at higher elevations. In Haleakala Crater behind Paliku Cabin, adults in abundance were found on a wet mountain-side where water steadily dripped down on a thick mat of algae. At the base of the dripping bank was a small pool along the margins of which were many adult *oahuense* apparently feeding on the algae. Immatures were not found even after a thorough examination of the algae attached to the rocks.

I have not seen the immature stages of this species. The statement by Williams (1938:104) that the early larval instars have spines on the posterior spiracular tubes while the later instars have palmate hairs is highly doubtful. It is probable that Williams was working with mixed species. Since their adult habitats are essentially the same, the larvae and pupae of *oahuense* probably closely resemble those of *hawaiiensis* and *bryani* in having palmate hairs on the posterior spiracular tubes in all stages; this has been found to be the case in all the inhabitants of slow-moving or standing water.

Neoscatella sexnotata (Cresson) (fig. 123d)

Scatella sexnotata Cresson, 1926, Proc. Haw. ent. Soc. 6:275; Williams, 1938, Proc. Haw. ent. Soc. 10:100. Holotype and allotype in B. P. Bishop Museum.

Neoscatella sexnotata Cresson, 1935, Trans. Am. ent. Soc. 61:360; Wirth, 1948, Proc. Haw. ent. Soc. 13:292.

Originally described from Oahu (type locality: Waimanalo), this species is now found on Kauai, Molokai, Maui, Hawaii, the Leeward Islands (Nihoa, Necker, and Laysan), and Wake Island (Micronesia). As this is a common

shore-line and low-land species, it is very likely that it also occurs on some of the other Pacific Islands to the west and south of Hawaii.

Medium to large, opaque brownish species with six pale spots on the wings, including one in cell R_1 ; two pairs of acrostichals, including one postsutural; four pairs of dorsocentrals, three of which are postsutural (anterior-most of the latter three pairs are weak); and fore femora with well-developed post-flexors.

This species is similar to *N. bryani* in the wing spotting. However, whereas *bryani* often has two additional pale spots at the apex of cells R_3 and R_5 , there are always only six spots in *sexnotata*. Moreover, *sexnotata* differs from *bryani* in its brown color, in possessing two pairs of acrostichals (one pair postsutural), and in having long post-flexor bristles on the fore femora.

Female ventral receptacle as in figure 123d.

Of all the Hawaiian *Neoscatella*, *sexnotata* is the most common species along the seashore and in estuarine conditions of streams and canals. In my experience, this species does not occur in forest, nor very far inland. Cresson (1926:276) was probably referring to the habitats of another *Neoscatella* (i.e., *bryani*) when he stated regarding *sexnotata*, "The species is widespread throughout the group [Hawaiian Islands], especially in the lowlands and lower forests." *N. bryani* was very likely mistaken for *sexnotata* by Swezey and Williams (1938:188) when they reported *sexnotata* "breeding in the water in an exposed tree hollow at 6,000 feet at Nauhi."

Perhaps the best description of *sexnotata* habitats was given by Williams (1938:100-101), "It favors stagnant saline pools—such as formed by particularly high tides, marshes and mudflats that often glisten with salt crystals—also occurs on tidal flats, wet beach sand and tide rocks and has been observed at reservoirs near the sea" On the island of Oahu, large populations have been found along the muddy margins of Kaelepulu Pond (Kailua), Salt Lake (Aliamanu), Ala Wai Canal (Waikiki), and Kuapa Pond (Hawaii Kai). On Maui, this species is very abundant in Kanaha Pond (Kahului).

Adults and immatures have been collected from various locations on Oahu, as well as Kanaha Pond on Maui, particularly on algae-covered rocks, among floating debris in the water, and on decaying organic material in the mud along the water's edge. All stages are especially numerous along margins where the water is calm and where organic debris tends to accumulate and decay.

Eggs are laid on moist substrates, in algal mats on rocks, on decaying plant parts, and other organic material. Both adults and larvae apparently feed on algae and microorganisms in their substrate. The larvae are semi-aquatic and can remain completely submerged in water for long periods while foraging for food. Usually, however, in liquid media, the posterior spiracular tubes of the larvae penetrate the surface film, and the groups of palmate hairs at the apex of the tubes spread out over the water surface. These characteristic palmate hairs, as well as the reduced spination on the body and features of the posterior spiracular tubes, place *sexnotata* in the group of Hawaiian *Neoscatella*, which inhabit standing or calm water environments.

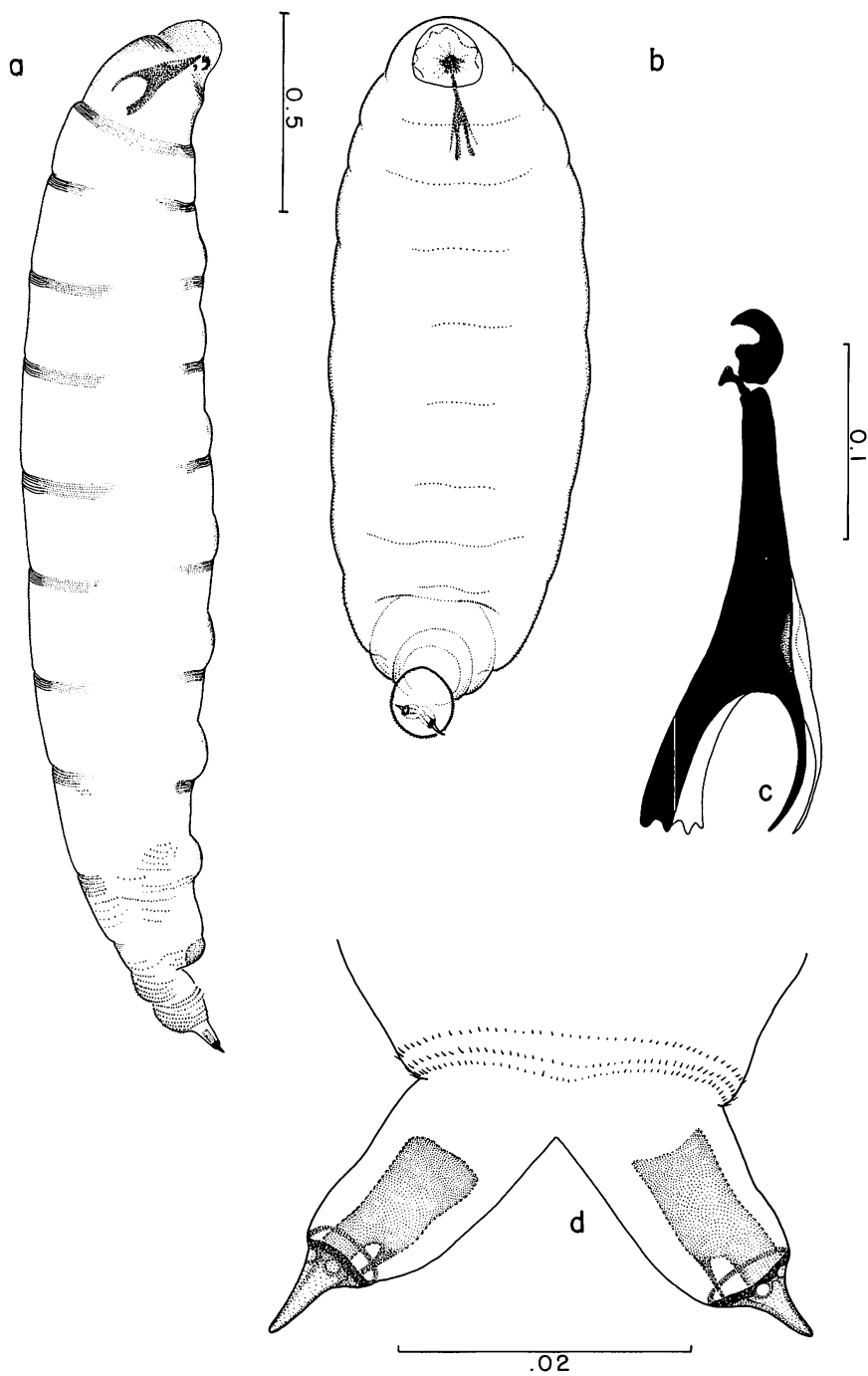


Figure 128—*Hydrellia williamsi* Cresson: a, larva, lateral; b, pupa, ventral; c, cephalopharyngeal skeleton; d, larva, posterior end, dorsal.

The larvae and puparia appear to be dimorphic, having forms with both long and short posterior spiracular tubes. Dissected pupae of the long form contained preadults of both sexes of this species, as did the dissected pupae of the short form. For further details, refer to this species in the section on immatures below.

***Neoscatella terryi* (Cresson)**

Scatella terryi Cresson, 1926, Proc. Haw. ent. Soc. 6:275; Williams, 1938, Proc. Haw. ent. Soc. 10:100. Holotype male in the B. P. Bishop Museum.

Neoscatella terryi Cresson, 1935, Trans. Am. ent. Soc. 61:360; Wirth, 1948, Proc. Haw. ent. Soc. 13:293.

Endemic. Oahu (type locality: Waimanalo Beach near Koko Crater).

This species differs from *N. hawaiiensis* in its olive-brown color and from *N. oahuense* in its well-developed inner vertical bristles.

This opaque brownish-olive, medium-sized species may be recognized by the five pale spots on the wings, the sparse mesonotal setulae, and the well-developed inner vertical bristles.

This is the poorest known of the Hawaiian *Neoscatella*, no immatures ever having been reported. To date, *terryi* adults have been found only on Oahu along the seacoast, principally on rocks.

***Neoscatella warreni* (Cresson) (fig. 124b)**

Scatella warreni Cresson, 1926, Proc. Haw. ent. Soc. 6:276. Holotype and allotype in B. P. Bishop Museum.

Neoscatella warreni, Cresson, 1935, Trans. Am. ent. Soc. 16:360; Wirth, 1948, Proc. Haw. ent. Soc. 13:284.

Neoscatella fimbriata Wirth, 1948, Proc. Haw. ent. Soc. 13:286. **New synonymy.**

Endemic. Maui (type locality: Haipauena), Kauai, Oahu, Molokai, and Hawaii.

The junior synonym, *N. fimbriata* Wirth (type locality: Palolo Valley, Oahu) was described to incorporate the Oahu populations which were thought to differ from *warreni* in "lacking the two pale wing spots, in the smaller size, and in possessing well-developed erect bristles on the fore tarsi of the male" (Wirth, 1948:287). However, Wirth noted that Williams' figure of the wing of a specimen from Lulumahu Stream near Honolulu showed one distinct and one pale spot.

I have now examined populations from the five major islands and have found that *warreni* is an extremely variable species whose range of variations incorporate the characteristics which Wirth utilized to separate *fimbriata*. I am convinced that Wirth's *fimbriata* represents one extreme of the *warreni* variations.

The Oahu populations, which Wirth considered *fimbriata*, contain many

specimens which have distinct wing spots, as well as those without wing spots. The setae on the front tarsi of the male are often well developed, but some specimens have the setae poorly developed, as in the typical *warreni*. The Oahu specimens vary a great deal in size, ranging from 2.0 mm. to 3.5 mm. in length. All of these variations can be seen in the population from one stream.

Kauai specimens often have darker wings; therefore, the two pale wing spots show up more distinctly.

Molokai populations contain individuals without, or with but very faint, wing spots, as well as those with distinct wing spots. The setae on the front tarsi of the male are variable, sometimes erect. This erectness is not necessarily associated with the absence of wing spots (as it should be in Wirth's concept of *fimbriata*.)

Maui and Hawaii populations correspond to the description of the typical *warreni* more closely than do any on Kauai, Oahu, or Molokai. Typically, the wing has two spots and the individuals are generally larger. However, again, individuals from both Maui and Hawaii sometimes exhibit very faint wing spots and variable setation on the front tarsi of the male.

It is therefore evident that *warreni* is an extremely variable species in which various combinations of the following characters may occur: 1) presence or absence of wing spots; 2) distinctness of the wings spots, if present; 3) male front tarsi setal development; and 4) size and general coloration.

Opaque to subshining dark brownish-black species, *warreni* may be distinguished from all other Hawaiian *Neoscatella* by the following combination of characters: medium to large in size (2.0-3.5 mm.); wings with two distinct pale spots, with two faint, pale spots or without pale spots; male front tarsi with erect setae, somewhat erect setae, or without erect setae, in any case the tarsi otherwise unmodified; inner and outer vertical bristles always well developed; oral and fore femora post-flexor bristles generally well developed; and other bristles and setulae moderately to well developed. Female ventral receptacle as in figure 124b.

Williams (1938:106) noted that *warreni* "favors swift flume and ditch water, rushing streams, waterfalls, and cool water-sheeted banks of uplands." Of all the known Hawaiian ephydriids, this species is the most common and widespread inhabitant of swift streams. In open-swift stream habitats, it is particularly abundant on moist, algae-covered rocks and boulders in the most turbulent part of the stream, where the water constantly churns and splashes around boulders and rocks. In some places this species is so abundant that adult flies literally cover the exposed surfaces of stream rocks. In these situations eggs can be seen plastering the rocks, the white blotches of eggs visible from a distance of 50 feet or more. Adults can be observed feeding on moist algae on the rocks, their probosces working rapidly forward and backward. When interrupted by splashing water, the flies momentarily fly off the substrate in unison and again, in unison, immediately return to resume feeding.

Eggs are laid on moist rocks in algae above the water line. As the eggs hatch, larvae feed in the surrounding area, most foraging for food above the water

line, although it is not uncommon to find them underwater as well. The larvae are difficult to see since they blend well with the dark, muddy color of the rocks. Furthermore, they often crawl into small depressions in the rocks and remain stationary. Pupae are generally found underwater in small depressions or crevices in the rocks and within the algal mat; some may be found beneath small rocks submerged under as much as two feet of flowing water.

Descriptions of larvae and pupae of this species are given in the section on immatures.

Genus **SCATELLA** Robineau-Desvoidy

Scatella Robineau-Desvoidy, 1830, Essai Myodaires, p. 801. Type-species, *buccata* Robineau-Desvoidy, by subsequent designation (Coquillett, 1910:603), = *stagnalis* (Fallén).

Trixostomus Rondani, 1856, Dipt. Ital. prodromus 1:130.

In this study, I am following Wirth's and Cresson's treatment of the *Scatella* group in considering each complex as a distinct genus.

Scatella *sen. str.* is characterized by having two pairs of laterocline orbitals, one pair of presutural acrostichals and two pairs of dorsocentrals, only the postsutural pairs developed.

Two species of this genus are presently known in Hawaii, one of them a new immigrant to the islands and the other described here as a new species.

KEY TO SPECIES OF SCATELLA IN HAWAII

1. Wings with numerous (more than five) white spots.
Frons polished black between ocellar tubercle and eye margin. **wirthi** n.sp.
Wings with only five white spots. Frons uniformly brown to dark brown, but not polished.
. **stagnalis** (Fallén).

Scatella stagnalis (Fallén) (fig. 124d)

Ephydra stagnalis Fallén, 1813, K. Vetensk. Akad. Handl. 34:248. Type in Zoological Institute, University of Lund.

Scatella buccata Robineau-Desvoidy, 1830, Essai Myodaires, p. 801.

Scatella stagnalis, Walker, 1849, List. Dipt. Brit. Mus. 4:1104.

A complete list of synonymies of this species is given by Sturtevant and Wheeler (1954:181).

Oahu, Hawaii. The latter is a new island record. A rather recent introduction, first collected in March, 1967.

Immigrant. Described from Sweden.

S. stagnalis is easily distinguished from *S. wirthi* n.sp. in having only five pale spots on the wings.

Small brown species. Pale spots on the wings occur in the following cells:

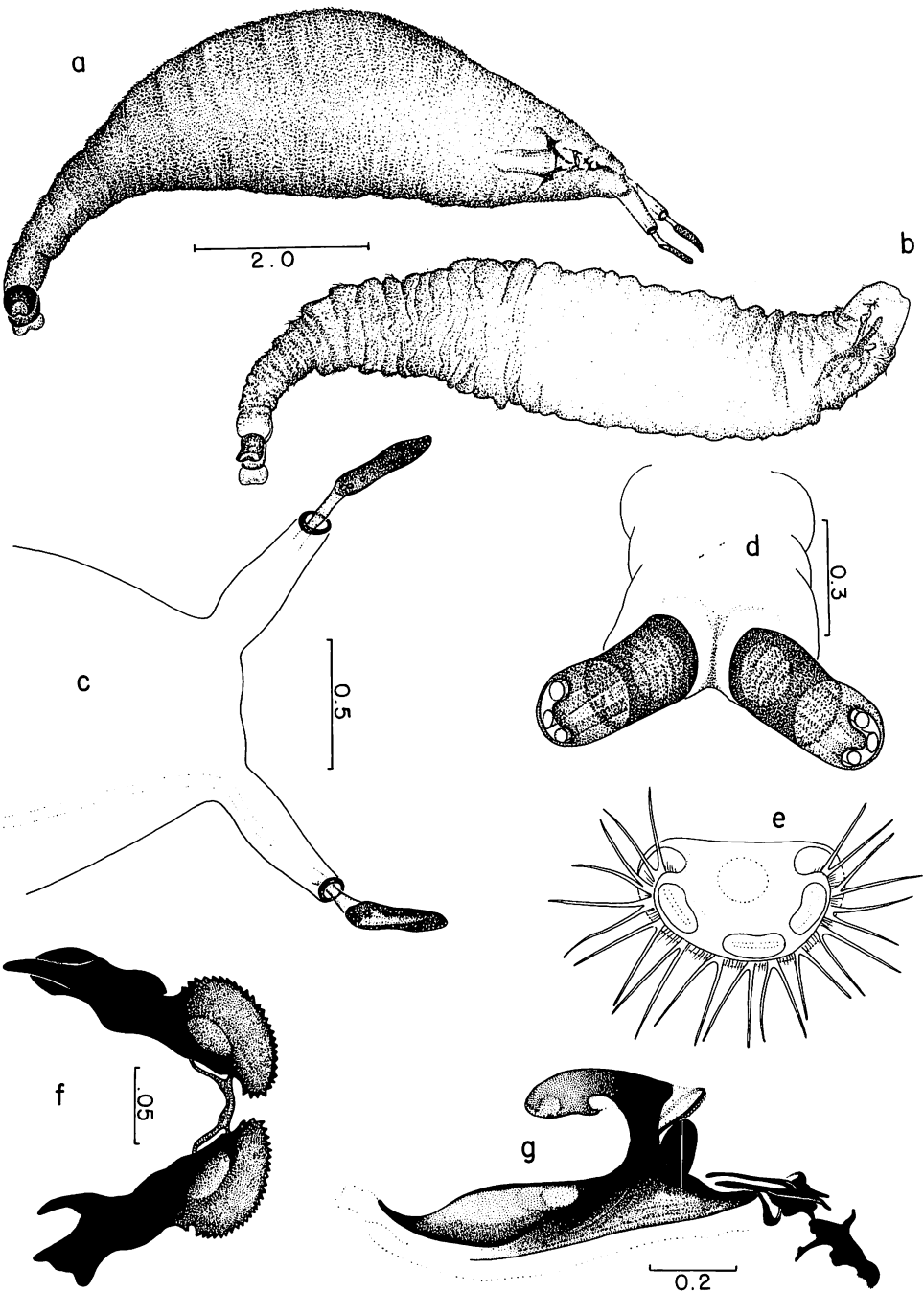


Figure 129—*Brachydeutera hebes* Cresson: a, pupa, lateral; b, larva, lateral; c, pupa, anterior spiracles; d, larva, posterior spiracles; e, posterior spiracle, apical; f, mouthhooks, dorsal; g, cephalopharyngeal skeleton.

one in cell R_3 ; two in cell R_5 ; one in the first M_2 cell; and one in the second M_2 cell. Sides of thorax on lower portion and anterior face of femora, grayish-brown. Frons and mesonotum subshining brown. Face, mesopleura, notopleura, and anterior margin of mesonotum somewhat golden-brown. Abdomen concolorous with mesonotum and scutellum. Female ventral receptacle as in figure 124d.

The larvae and pupae of this species are indistinguishable from those of *N. hawaiiensis* and *N. bryani*, and are described in the section on immatures under *hawaiiensis*. The adults and immatures of *stagnalis* are common primarily in standing water, both fresh and stagnant. They may also be found in predominantly fresh water which is inundated by salt water, such as the Ala Wai Canal (Oahu), Enchanted Lake (Oahu), and Waiakea Pond (Hawaii). On Oahu, in brackish water situations, it is often found in association with *N. sexnotata*; in more fresh water habitats, it is usually seen in association with *N. bryani* and *N. hawaiiensis* along margins of open-slow and closed-slow streams.

Scatella wirthi Tenorio, new species (figs. 118a-c, 124c)

Small, brownish species with patches of gray. Wings with numerous white spots and frons polished brown to black on posterior two-thirds to three-fourths.

The numerous spots on the wings of this species suggest relationship with members of the genus *Limnellia*. This fact was mentioned by Hardy (1952:468), when he reported a specimen from Volcano, Hawaii, identified by W. W. Wirth as a genus between *Limnellia* and *Scatella*. However, the two laterocline orbitals, the strong presutural acrostichals, and the postsutural dorsocentrals place this species in the genus *Scatella*. *Limnellia* has only one laterocline orbital.

S. wirthi is easily distinguished from *S. stagnalis* by having the wings with numerous white spots of varying size and shape and the frons polished between the ocellar tubercle and the eye margins.

MALE and FEMALE. *Head* (figs. 118b, c): Head a little less than one-fifth higher than long. Frons about 1.6 times wider than long, polished brown to black on posterior two-thirds to three-fourths between the ocellar tubercle and the orbital plate, otherwise pollinose brown. Two laterocline orbitals; inner and outer verticals and ocellars well developed. Face generally pollinose brown with vestitures of gray, black around bases of facial bristles and setulae; upper portion of face somewhat carinate and weakly tuberculate at ventral apex of the carina. Four to five unevenly developed facials in a diagonal series, the longest bristle ventrolateral and situated closest to the oral margin; four moderately developed oral bristles in a row on each side of the median. Parafacies narrow and gray, no parafacials, although two to three minute hairs are present. Gena mostly gray, darker posteriorly; one moderately developed genal bristle and several fine hairs. Eyes large, about four-fifths as high as head. Antenna black, third segment minutely pubescent, arista short-haired.

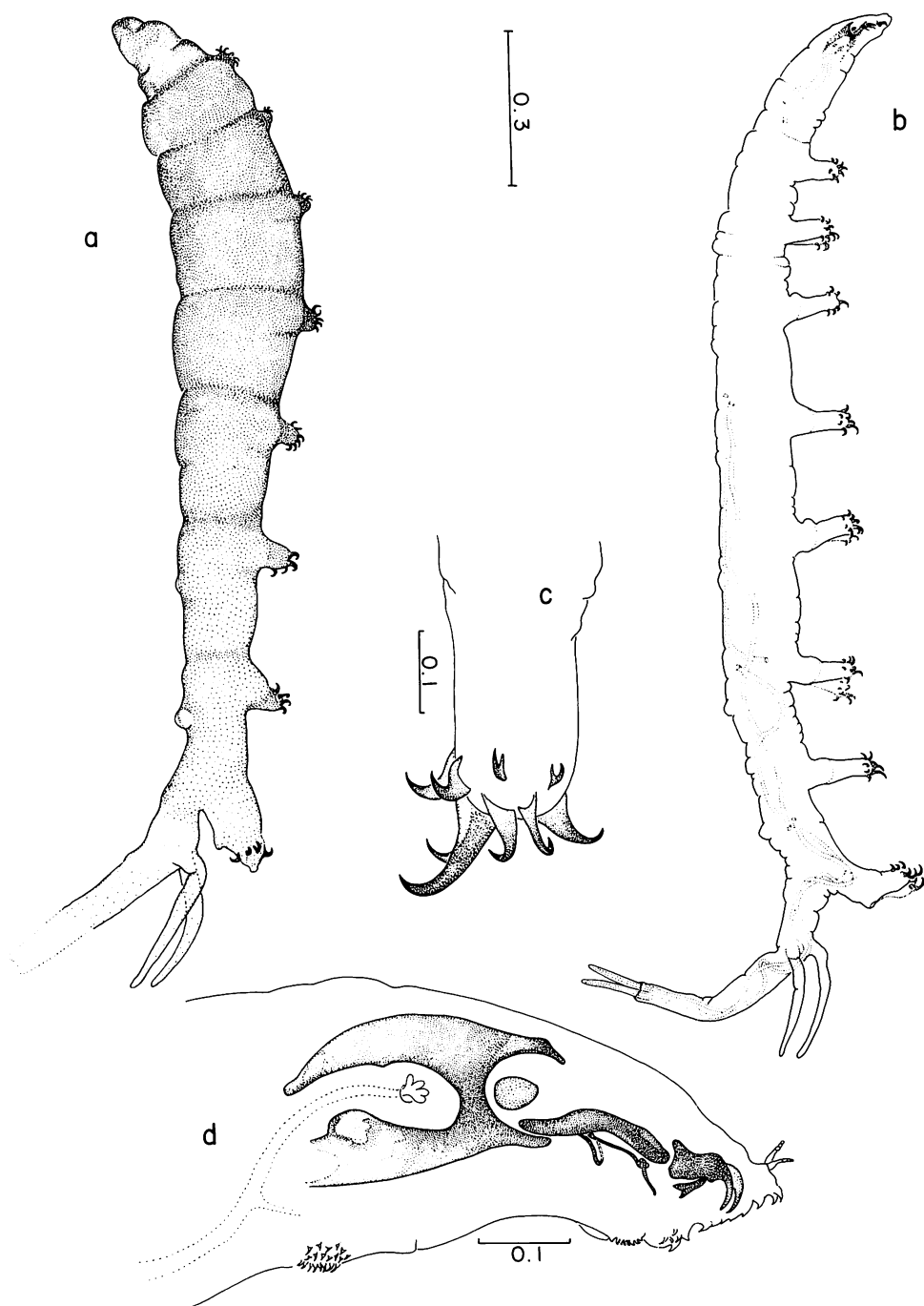


Figure 130—*Ephydra cinerea* Jones: a, pupa, lateral; b, larva, lateral; c, larva, 4th pseudopod, lateral; d, larva, anterior end, lateral.

Thorax: Generally pollinose brown with spots or blotches of gray, especially at the anterior and lateral margins of the mesonotum. Disc of mesonotum and scutellum subshining brown. Mesonotal setulae greatly reduced. Presutural acrostichals weaker than the postsutural dorsocentrals. Presutural, intraalar, and postalar bristles well developed. Two strong apical scutellars and a pair of lateral scutellars about one-third as long, or less, than the apical scutellars. Two notopleurals; the posterior placed slightly higher than the anterior. Mesopleura and sternopleura each with one well-developed bristle. Halteres with yellow knobs and reddish brown stems. *Legs*: With coxae dark gray, femora and tibiae dark brown, lighter in some specimens; tarsi sometimes lighter brown than femora and tibiae. Fore femur with five to six post-flexor bristles, about as long as diameter of femur. *Wings* (fig. 118a): Approximately two times longer than wide, brown with numerous white spots of irregular size, shape, and number. Veins undulating. *Abdomen*: Brown, apical margins of tergites grayish. Female with posteriorly curved spine at the anterior end of cerci. Female ventral receptacle as in figure 124c.

Length: body, 1.8 mm.; wings, 2.1 mm.

Holotype male and allotype female, Hawaii, Keanakolu, Kaula Gulch, 7000 ft., October 29, 1952 (C. P. Hoyt). 9 paratypes of both sexes same data as types. 90 additional paratypes (41 females, 49 males) as follows. Maui: Paliku, Haleakala, September 12, 1968 (J. A. Tenorio, sweeping over mud); Paliku, Haleakala, 6000 ft., July, 1952 (D. E. Hardy); Holua, 6500 ft., June, 1953 (D. E. Hardy); Haleakala, 10,000 ft., September, 1956 (J. W. Beardsley); Haleakala, March 23, 1932 (O. Bryant, ex. *Coprosma*); Oili Puu, Haleakala, July 23, 1965 (J. W. Beardsley); Puu Niania, 7000 ft., April, 1954 (M. Tamashiro), July, 1956 (R. Namba, D. E. Hardy); Haiku, March, 1956 (N. L. H. Krauss); Kula Pipe Line, 4600-5000 ft., March 15, 1932 (O. Bryant). Hawaii: Kulani, 5200 ft., August, 1952 (W. C. Mitchell); Upper Olaa Forest, 4000 ft., July, 1956 (D. E. Hardy); Hamuula, August 7, 1935 (R. L. Usinger); Kilauea, August, 1949 (D. E. Hardy); Hualalai, October 19, 1963 (D. E. Hardy); Pauahi, August 12, 1949 (D. E. Hardy); Puu Kalepa Pond, 8000 ft., October, 1952 (D. E. Hardy); Lake Waiau, Mauna Kea, October, 1951 (E. Dresner).

Holotype, allotype, and 10 paratypes in B. P. Bishop Museum; 10 paratypes each to the U.S. National Museum and British Museum (Natural History); 59 paratypes in the University of Hawaii collection.

Scatella wirthi is apparently restricted to high elevations from 4000 ft. to approximately 13,000 ft. above sea level. The majority of specimens examined were found from 6000 ft. and above. It is interesting to note that this species occurs only on Maui and Hawaii, the two highest and largest islands in the Hawaiian chain.

The adults are presumably found along muddy margins of pools, puddles, ponds, and slow-moving streams at the higher elevations.

It is my pleasure to name this species in honor of Dr. Willis W. Wirth, who has contributed much to systematics of the Hawaiian Ephydriidae.

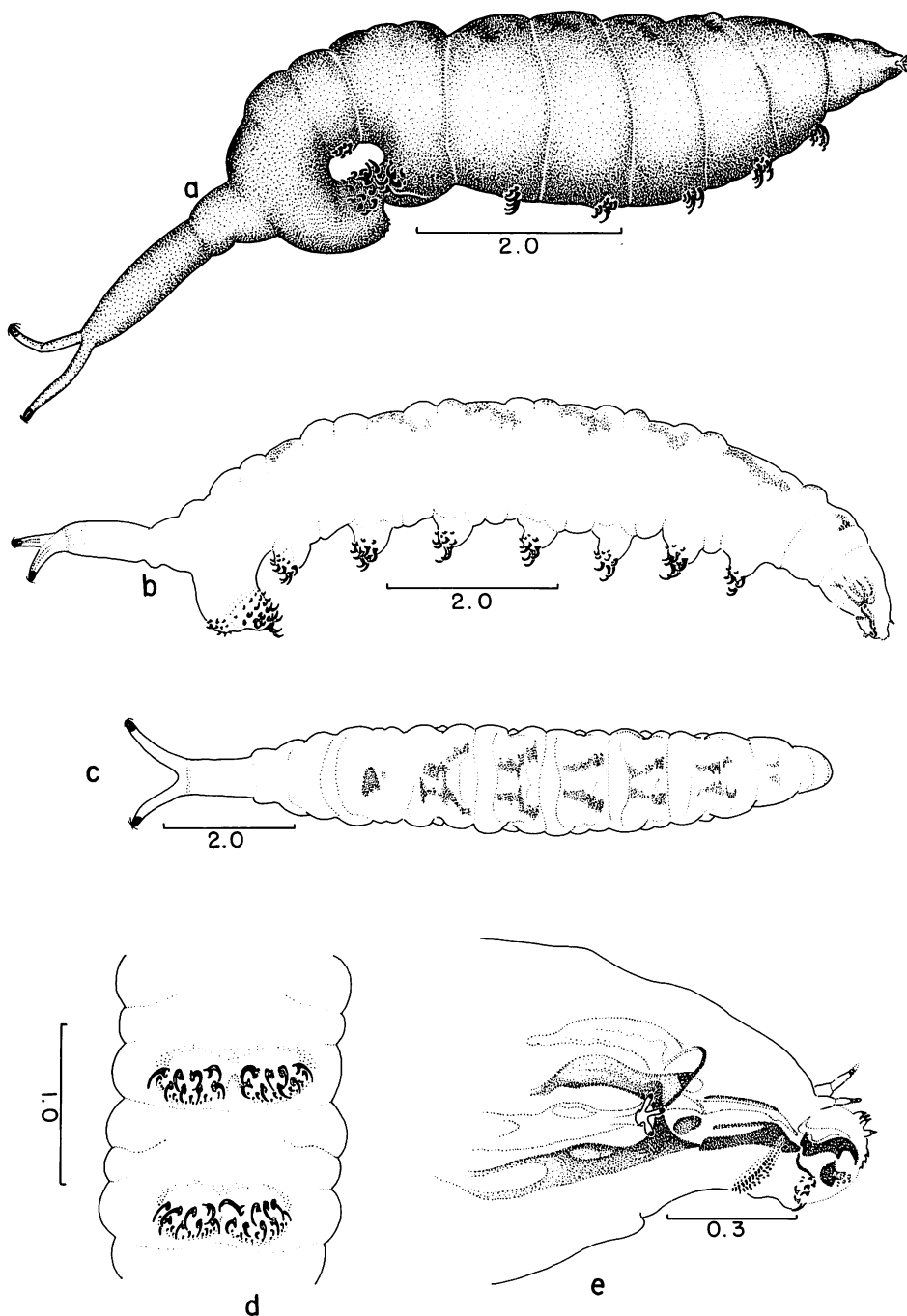


Figure 131—*Ephedra milbrae* Jones: a, pupa, lateral; b, larva, lateral; c, larva, dorsal; d, larva 4th and 5th pseudopods, ventral; e, larva, anterior end, lateral.

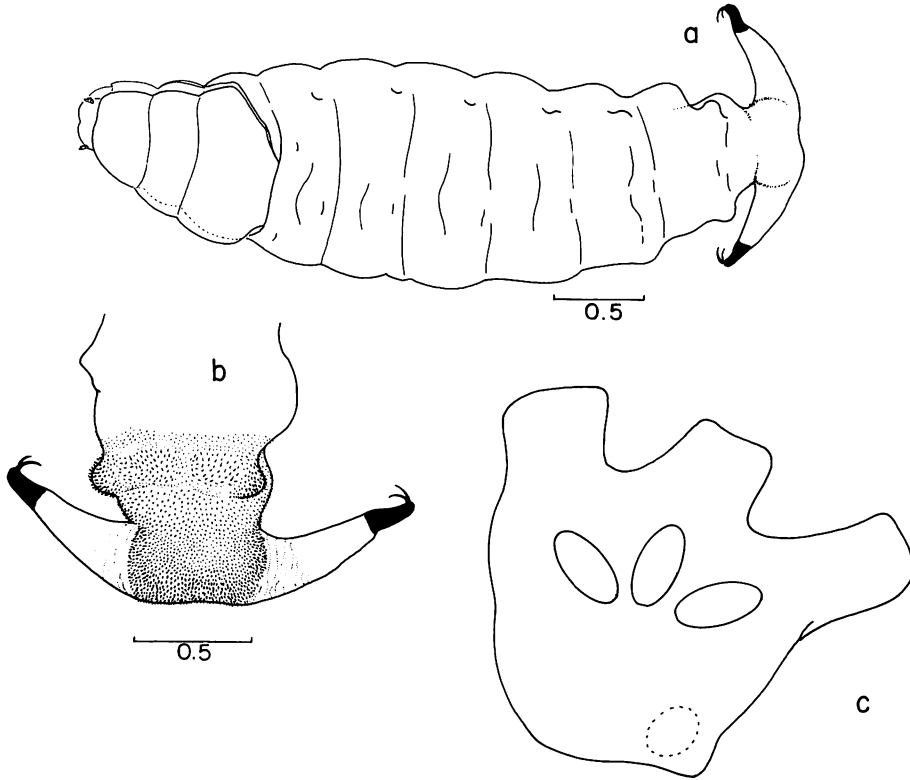


Figure 132—*Apulvillus muiensis* Wirth: a, pupa, dorsal; b, pupa, posterior end; c, posterior spiracle, apical (diagrammatic).

IMMATURES

The species discussed in this section are those in which adults and immatures have been correlated, either through rearings or through dissection of mature pupae.

Morphological features which have been used here to differentiate larvae and pupae of the Ephydridae are briefly as follows: the shape of the anterior respiratory organs and the number of finger-like projections (digits) forming the margins of the spiracles; the setation and ornamentation of the body surface; the presence or absence of leg-like outgrowths (pseudopods) on the ventral surface of the body segments; the length, shape, and position of the posterior spiracular tubes; the armature associated with the posterior spiracular openings, i.e., branched or unbranched hairs or strong spines; and relative size.

The anterior respiratory organs are small and usually digitate, in the Hawaiian material studied, having from 2 to 15 digits. Occasionally, the anterior spiracles are apparently absent (*Hydrellia*), invaginated in the larva

(*Brachydeutera*), or greatly developed in the pupa (*Brachydeutera*). The body may be ornamented with heavy setulae (some *Neoscatella*), covered with dense hair (*Brachydeutera*), or practically bare. Pseudopods in the Hawaiian species are absent, except in the genus *Ephindra*, whose members have eight pairs of pseudopods provided with strong claws. Ambulatory warts are present ventrally in many species. The posterior respiratory organs are usually borne on spiracular tubes which are paired and which may be slightly projecting tubercles or elongated tubes capable of retraction. The number of posterior spiracular openings is usually three or four, except in *Hydrellia*, in which the opening is apparently slit-like.

Johannsen (1935) gives a brief account of the general features of the larvae and pupae of the Ephyridae. Regarding the pupae, he states (p. 49), "The pupa is inclosed in the puparium, or last larval skin. This puparium, owing to the presence of the thick-bodied pupa within, is more swollen than the larva and is markedly convex ventrally. The larval head segment, together with the mouth-hooks, are retracted into the thoracic segments. . . . At the emergence of the fly, the more or less flattened tergal half of the first three segments breaks off, and in some cases the corresponding ventral part also."

Based on the morphology of the posterior spiracular tubes and body spination of the larvae, two general groups of larvae in the Hawaiian species (with the exception of *Hydrellia*) may be delineated. In the first group, the larvae have palmate "hydrofuge" hairs (after Wigglesworth, 1947:199-201) surrounding the posterior spiracular openings (figs. 125e, 127a, 135d, e), and, in the second group, the larvae possess strong, curved spines associated with these openings (figs. 133a-c, 134a-d). The kind and number of the palmate hairs and curved spines are useful in differentiating some species within these two groups.

It may be offered as a general statement that species with larvae bearing palmate hairs frequent calm or standing water habitats, and those possessing spines on the posterior spiracular tubes are associated with flowing water habitations, usually in swift streams or flumes. Only larvae and pupae of *Neoscatella* and *Apulvillus* have been found in streams to date.

Within the *Neoscatella*, further morphological adaptations apparently associated with larval habitat can be readily distinguished. Those species inhabiting calm, stagnant and standing water not only bear palmate hairs surrounding the spiracular openings, but also have relatively weak body setation and bare, retractile, posterior spiracular tubes. The "hydrofuge" hairs, which spread out over the surface of the water, break the tough surface film and allow direct contact of the spiracles with the air above. The retractile tubes allow the larvae to vary their distance from the water surface as they forage for food, while still maintaining contact with the atmosphere (for this group, see figs. 135, 138, 139).

The other species of *Neoscatella* which have become adapted to swift and often turbulent streams, bear strong, hook-like spines at the apex of the posterior spiracular tubes. In addition, these tubes are usually strongly spined and not retractile. The body is covered with relatively strong spines when com-

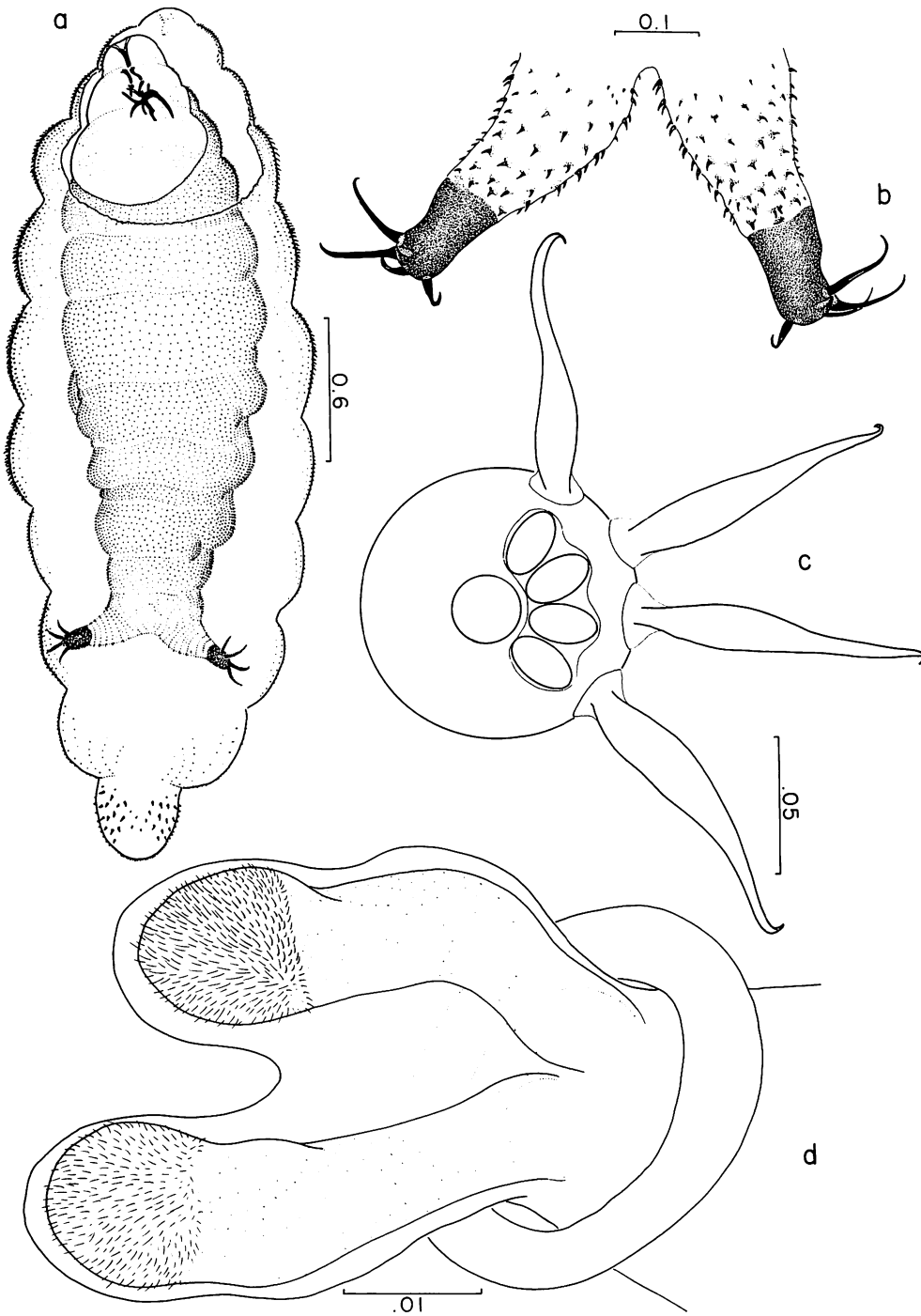


Figure 133—*Neoscatella cilipes* Wirth: a, in *Procanace* sp. (Canaceidae) puparium. *N. clavipes* Wirth: b, pupa, posterior end, dorsal; c, posterior spiracle, apical; d, anterior spiracle, 2-digit form.

tapered end (figs. 129a,b). Hairs surrounding spiracular openings unbranched, appearing paired (fig. 129e). Larva densely clothed in short hairs. **Brachydeutera hebes** Cresson.

- 4(3). Body segments with lateral margins dorsally and ventrally expanded into pointed spines, small spine-like projections also present on dorsal and ventral surfaces of segments (figs. 125a,b). Anterior spiracles of puparium with numerous digits, about 15 (fig. 125d). Puparium comparable in size to full-grown larva.

. **Placopsidella cynocephala** Kertész.

Body segments without such expansions, with smooth outline (fig. 126b). Anterior spiracles with fewer digits, about six (fig. 127b). Puparium about two-thirds the length of mature larva (fig. 126a). **Hecamede persimilis** Hendel.

- 5(2). Ventral surface of body segments with eight pairs of pseudopods bearing heavily sclerotized, claw-like spines (figs. 130b, 131b), the eighth pair more strongly developed (Genus *Ephydra* Fallén). 6

Ventral surface of body segments without pseudopods, or pseudopods very weakly developed, and without strong claw-like spines, the pair on the eighth segment not larger than the others. 7

- 6(5). Pseudopods on body segments much longer than wide, distinctly separated into pairs on each segment (fig. 130b). Abdomen terminating in a long fleshy "tail" from which the spiracular tubes arise, and a pair of long, fleshy filaments projecting posteriorly at basal one-third of tail (fig. 130b). **Ephydra cinerea** Jones.

Pseudopods short, about as wide as long, the pairs not distinctly separated (fig. 131d). No prespiracular fleshy filaments present at base of "tail." Dorsum of abdominal segments with a pattern of dark spines (fig. 131c). **Ephydra milbrae** Jones.

- 7(5). Posterior spiracular tubes each with four groups of long, multiple-branched hairs surrounding the spiracular openings (fig. 135e). Found in slow-moving or quiet bodies of fresh or brackish waters. 8

Posterior spiracular tubes each with at least three strong spines associated with the spiracular open-

Body spines relatively weak, but may be developed laterally and ventrally on ambulatory warts. Posterior spiracular tubes either with tiny spinules or bare apically; tubes stubby, or thickened, especially at base (figs. 132b, 140c,d). 13

- 13(12). Posterior spiracular tubes with apical blackened portion about two times longer than wide, tubes tapered gradually from base to apex (fig. 132b). Bases of tubes with irregular rows of tiny dot-like spines, apical one-half of tubes more or less bare. Anal opening of puparium not expanded, slit-like. Apparently only three functional spiracular openings, the fourth reduced (fig. 132c).

. **Apulvillus mauiensis** Wirth.

? **Apulvillus williamsi** Wirth.

Posterior spiracular tubes with apical blackened portion less than two times longer than wide, about one and one-half times; tubes with small spines regularly placed along most of the length (fig. 140d). Anal opening usually partially or fully expanded, large and conspicuous in puparium (figs. 140c, 141c). Four spiracular openings of equal size evident. . . . **Neoscatella warreni** (Cresson).

For sake of convenience, I have arranged the genera and species alphabetically in the following descriptions.

Apulvillus mauiensis Wirth (figs. 132a-c)

No larvae of this species have been collected. However, two pupae from Halawa Stream, Molokai (in stream on rocks) were dissected and found to be this species. Two additional puparia, found at Boiling Pots, Hawaii, are very similar to the above and may belong to this species or *A. williamsi*. The puparium of *A. mauiensis* is similar to that of *N. warreni*, but the posterior spiracular tubes are thinner and more tapered toward the apices (fig. 132b). The spiracular tubes bear spines at their apices, but, in all specimens on hand, all but two of the spines are broken off; there is, however, a stump representing a third spine. Since there may actually be four spines in complete larvae and puparia, this species is being keyed out in the larval and pupal key under both alternatives. The posterior spiracular tubes appear to have only three distinct spiracular openings, with evidence of a reduced fourth (fig. 132c), the blackened portion at the end of tubes is longer in relation to the entire spiracular tubes, about one-fourth their length (in *warreni*, this portion is about one-sixth to one-eighth the length of the tubes); spiracular tubes with widely spaced rows of tiny spines basally, almost bare apically (fig. 132b). Anterior spiracles con-

spicuous, with three digits. Cephalopharyngeal skeleton similar to *Neoscatella*. Puparia about 4.3 mm.

Brachydeutera hebes Cresson (figs. 129a-g)

Very large, larva about 7.8 mm.; puparia around 8 mm. in length.

Larvae: Whitish, rather spindle-shaped, tapered caudally. Larva usually densely clothed in dark hair and end of body noticeably wrinkled (fig. 129b). Anterior spiracles present, but invaginated. Posterior spiracular tubes terminal, usually about one and one-half times longer than broad, with three spiracular openings (fig. 129d); outer walls of apex of tubes bordered by unbranched hairs which appear to be paired (fig. 129e). Cephalopharyngeal skeleton as in figure 129g; mouthhooks spatulate at apices and serrated (fig. 129f).

Puparia: Greatly convex ventrally near middle, the tail end greatly curved dorsally (fig. 129a). Anterior spiracular processes elongated and divergent; a long cylindrical basal segment arises at the extreme anterior end of body and a second, terminal, flattened segment bears on its margin numerous tiny spiracular digits; in the puparium, these digits appear as holes in the flattened segment (fig. 129c).

The life cycle of this species, based on Williams' studies (1938), may take as little as 14 days: the egg hatches in one day, the larva matures in eight days, and the pupal stage lasts five days. *B. hebes* is easy to rear in the laboratory from larvae taken in the field.

Ephydra cinerea Jones (figs. 130a-d)

Larvae and puparia average about 9 mm. in length, excluding the "tail" portion.

Larvae: White, two longitudinal tracheal trunks usually evident throughout most of the body length. Anterior spiracles evident, with three to four digits. The eight pairs of ventral pseudopods about three times longer than wide and bear at their apices claw-like spines which are blackened on their apical one-half (fig. 130c); the eighth pair is thicker than the others and separated only apically, the common portion forming the anal opening (fig. 130b). The body past the eighth pseudopod terminates in a long tail into which the posterior spiracular tubes may be retracted; at the basal one-third of the tail, a pair of long, thin, fleshy filaments project posteriorly. Spiracular tubes with four openings bordered by four groups of palmate hairs. Cephalopharyngeal skeleton and anterior portion of larva as in figure 130d.

Puparia: Brown, thicker on anterior one-half, the anterior end curved dorsally (fig. 130a). Pseudopods shorter than in larva, very short anteriorly and increasing in length posteriorly; eighth pseudopod projecting posteriorly.

Ephydra milbrae Jones (figs. 131a-e)

Larvae about 7 mm. in length; puparia slightly shorter, about 6.3 mm. (measurements exclusive of "tail").

Larvae: Dirty white in color, covered with short setae; dorsum of segments with a pattern formed by tiny dark setae (fig. 131c). Anterior spiracles with three digits. Anterior portion of larva and cephalopharyngeal skeleton as in figure 131e. Pseudopods on venter of segments not distinctly separated into pairs (fig. 131b), about as long as broad, terminating in groups of strong, dark, claw-like spines; eighth pseudopod wider and longer than others, with many more spines, and directed somewhat anteriorly (fig. 131b). Posterior end of body past eighth pseudopod ends in a slender tail which terminates with the retractile, long, narrow posterior spiracular tubes; no prespiracular fleshy filament present as in *E. cinerea*. Spiracular tubes with four openings and four groups of palmate hairs.

Puparia: Yellow-brown to brown. Pseudopods reduced to spines, except for eighth pseudopod which curves anteriorly to meet the posteriorly curved sixth pseudopod, forming a grasping structure which allows the pupa to remain firmly attached to a stem or other object during the pupal period (fig. 131a).

Hecamede persimilis Hendel (figs. 126a-c, 127a-c)

Larvae about 4.6 mm. in length; puparia much shorter, about 2.9-3.2 mm.

Larvae: Long, cylindrical, blunt posteriorly and more or less pointed anteriorly. White in color, practically featureless, the segments not well delineated and appearing smooth and hairless. If cleared in phenol, granular patches become evident on dorsal portion of segments. Posterior spiracular tubes very short, arising dorsoapically, bordered by two small ventroapical tubercles and two small lateroapical tubercles (fig. 126b); spiracular tubes with three spiracular openings and four groups of palmate hairs reaching to about rim of spiracular tube (fig. 127a). Head appearing bifurcate anteriorly, the anterior spiracular digits evident and usually about six in number (fig. 127b); refer to figure 126c for details of anterior portion of larva. Cephalopharyngeal skeleton as in figure 127c; mouthhooks smooth.

Puparia: Yellow-brown to brown in color, about two-thirds the length of mature larva; body surface corrugated (fig. 126a). Posterior spiracular tubes divergent and farther apart than in the larva.

Hydrellia williamsi Cresson (figs. 128a-d)

Larvae and pupae very small, larva about 2.6 mm. and puparium about 1.7 mm. in length.

Larvae: Whitish, smooth in outline, cylindrical, without conspicuous setae, except for the obvious, tiny setulae which ring the anterior margins of the body segments (fig. 128a). No external anterior spiracles evident in either larva or pupa. Posterior spiracular tubes each terminating in a conical, hollow, pointed projection which is probably used for piercing plant tissue (fig. 128d). Cephalopharyngeal skeleton lacks the anterodorsal bridge, and the mouthhooks are fused and finely serrated (fig. 128c).

Puparia: Yellow in color, even more cylindrical in outline than larva.

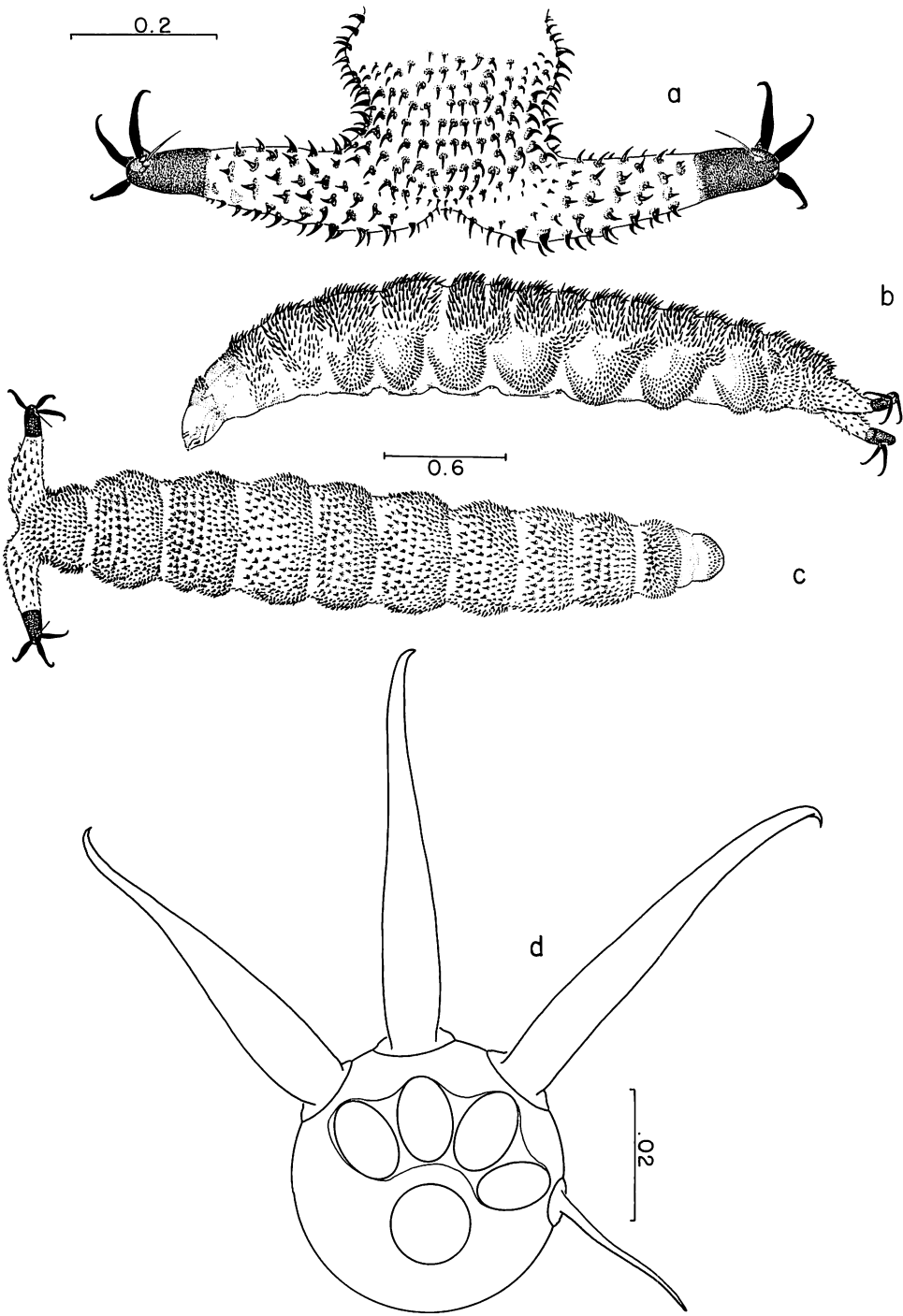


Figure 134—*Neoscatella clavipes* Wirth: a, larva, posterior end, dorsal; b, larva, lateral; c, larva, dorsal; d, posterior spiracles, apical.

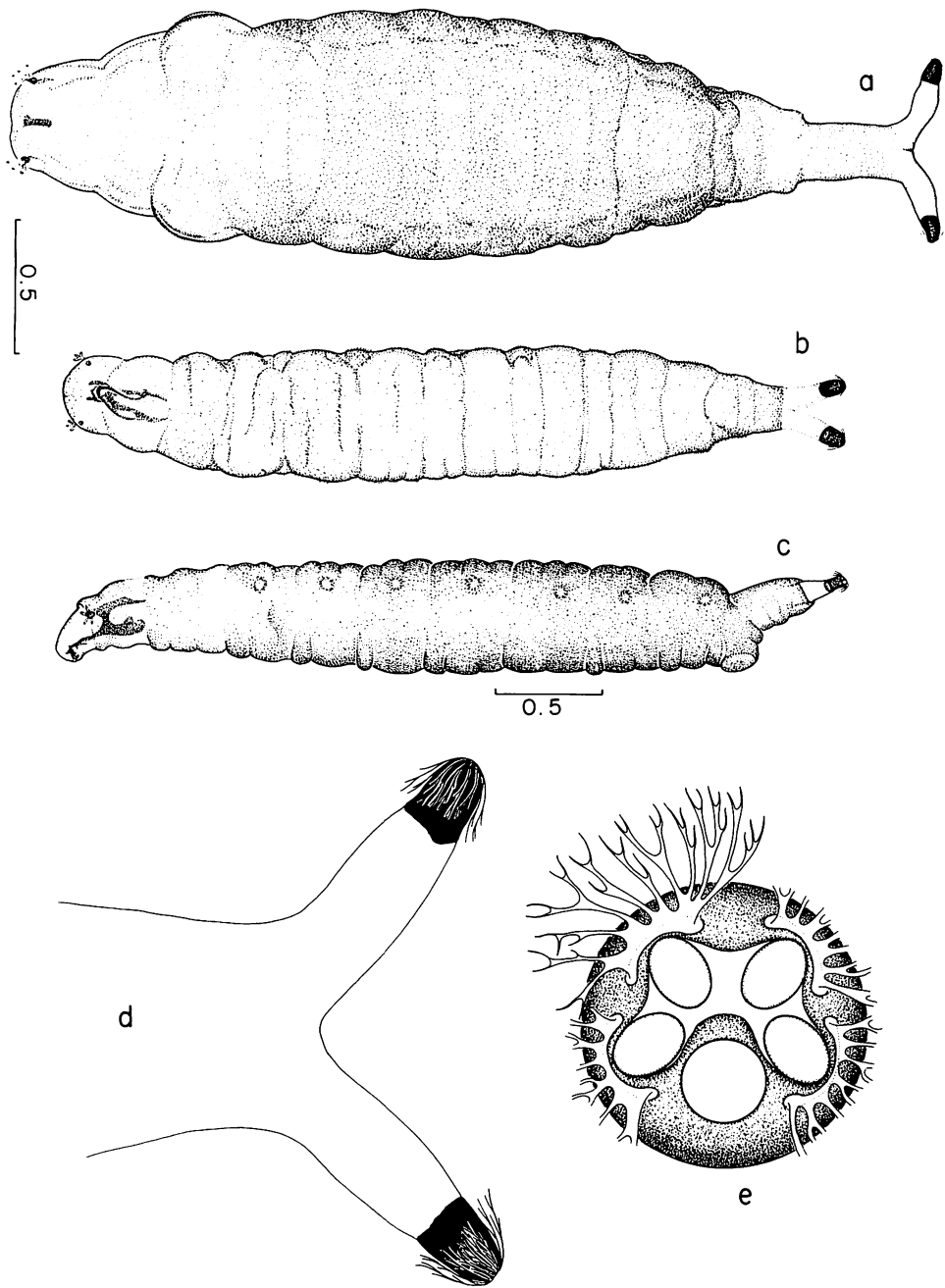


Figure 135—*Neoscatella hawaiiensis* (Grimshaw): a, pupa, dorsal; b, larva, dorsal; c, larva, lateral; d, posterior end, dorsal; e, posterior spiracle, apical.

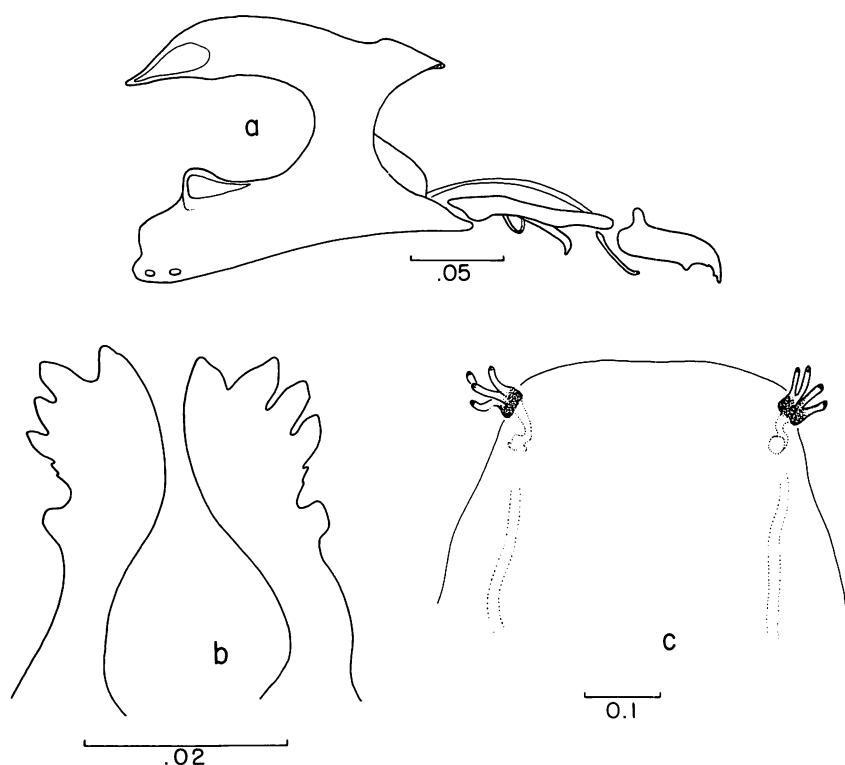


Figure 136—*Neoscatella hawaiiensis* (Grimshaw): a, cephalopharyngeal skeleton; b, mouthhooks, dorsal; c, anterior end of puparium.

Caudal end before spiracles forming a disc-shaped structure on which the spiracular tubes are borne (fig. 128b); the pupae are attached within the leaf by this caudal portion and the conical ends of the spiracular tubes are embedded in the plant tissue.

An excellent discourse on the biology of this species was presented by Williams (1938) in his notable studies of the biology of water-loving insects. The female lays its eggs on *Lemna* leaves and when the egg hatches, the larva works its way into the leaf tissue and continues to feed by mining the leaf. The larva takes from nine to ten days to complete its development, molting three times in the process. Pupation takes place within the larval mine, the duration of the pupal stage is from eight to ten days. The complete life cycle from egg to adult requires from 18 to 20 days.

***Neoscatella amnica* Tenorio, new species**

Essentially the same as, and practically indistinguishable from, the larvae and pupae of *N. clavipes* (four-spine form) and *N. cilipes*. Refer to the discussion under *N. clavipes* for information on the immatures of this species.

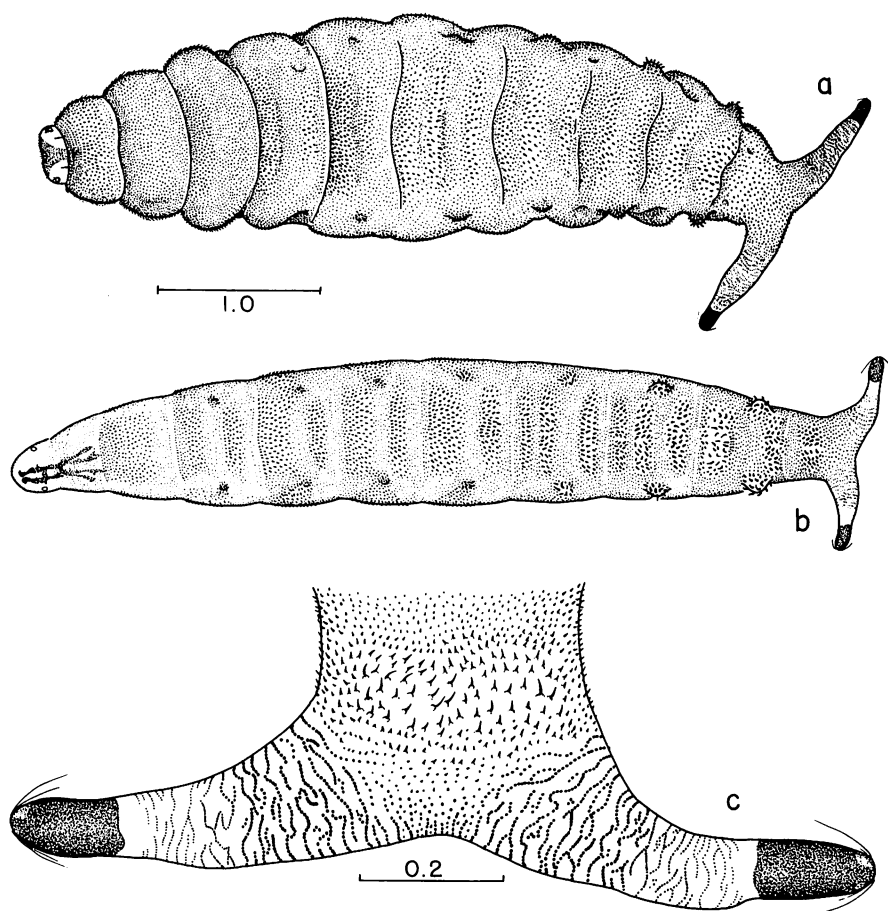


Figure 137—*Neoscatella kauaiensis* Wirth: a, pupa, dorsal; b, larva, dorsal; c, larva, posterior end.

Adults of both sexes were reared from larvae and pupae collected on algae-covered rocks in streams on Maui (Palikea and Kopiliula Streams).

***Neoscatella clavipes* Wirth (figs. 133b-d, 134a-d)**

This species appears to have two larval forms. Both forms have been correlated with adults of *clavipes* by dissections and rearings. I can find no differences in the adults reared from the two different forms. Larvae about 3.2–3.5 mm. in length; puparia 2.5–2.8 mm. (measured to fork of posterior spiracular tubes).

I have been unable to distinguish *clavipes* immatures (4-spine form) from those of *N. amnica*; they are also practically indistinguishable from immatures of *cilipes*.

3-spine form: Larva basically white, but strong, dark spines covering the

body give it a brownish appearance (figs. 134b,c); the base of each spine surrounded by an irregularly pigmented area. Anterior spiracles with four to six stout digits, rarely six. Posterior spiracular tubes usually directed laterally and with strong surface spines (fig. 134a); apex of tubes bear three strong, black, hook-like spines directed cephaloventrally and one fairly straight, light-colored bristle (fig. 134d); these spines are relatively longer and thinner than in the form below. Posterior spiracular tubes with four spiracular openings (fig. 134d). Puparium brown, body spines shorter, but still evident (fig. 133b).

The 3-spine form has been collected on Maui (Iao, Makamakaole, and Palikea Streams) and Hawaii (Pahoehoe Stream).

4-spine form: Almost identical to the above except for the following: anterior spiracles with two to three digits, rarely two (fig. 133d); and posterior spiracular tubes have four strong, black, hook-like spines at their apices (fig. 133c).

This form has been collected only on Hawaii to date (Pahoehoe and Kapue Streams and Boiling Pots).

***Neoscatella cilipes* Wirth (fig. 133a)**

The immature forms of this species are difficult to reliably separate from those of the 4-spine form of *clavipes*. Except for an apparent slight reduction in strength of body spines, other features are much the same as in *clavipes*. The anterior spiracles have three digits, the body has relatively strong body spines, and the posterior spiracular tubes have four strong, apical, hook-like spines associated with the four spiracular openings (fig. 133c).

The immatures of *cilipes* were found to predominate in Opaepala Stream, Oahu, and were found to be numerous at Sacred Falls, Oahu. At Kokee, Kauai, several *cilipes* pupae were found to have pupated inside *Procanace* sp. (Canaceidae) puparia (fig. 133a). This is no doubt the result of the *cilipes* larvae seeking shelter for pupation, as I have found other species of *Neoscatella* pupating inside puparia of members of their own species.

***Neoscatella hawaiiensis* (Grimshaw) (figs. 135a-e, 136a-c)**

Small larvae and pupae, maximum length of larvae about 4.0 mm.; of puparia, about 3.5 mm.

The larvae and puparia of *hawaiiensis* appear identical to those of *N. bryani* and *Scatella stagnalis*. I have been unable to separate the immatures of these species except by dissection of mature pupae.

Larvae: Generally white, with very sparse and short bristling on body (fig. 135b). Anterior spiracles with variable numbers of digits, usually three, four, or five digits; the same larva may have a different number of digits on each side of the body. Body of larva usually with warts evident dorsolaterally on most segments (fig. 135c). Posterior spiracular tubes bare, pigmented terminal portion usually black, about one-third to one-fourth as long as length of tubes, the tubes retractile (fig. 135d); four spiracular openings and four groups of

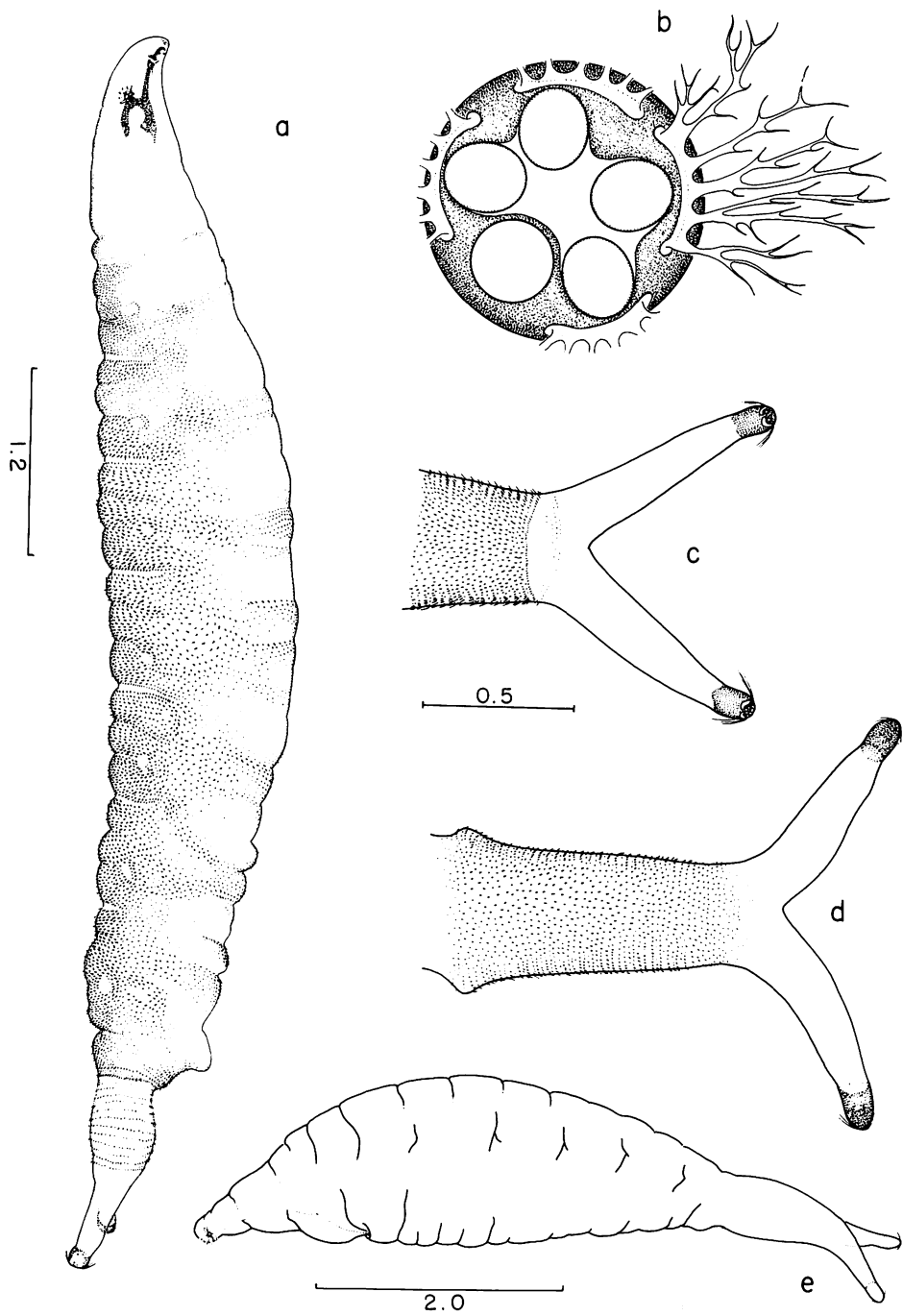


Figure 138—*Neoscatella sexnotata* (Cresson) (short form): **a**, larva, lateral; **b**, posterior spiracle, apical; **c**, larva, posterior spiracular tubes; **d**, pupa, posterior spiracular tubes; **e**, pupa, lateral.

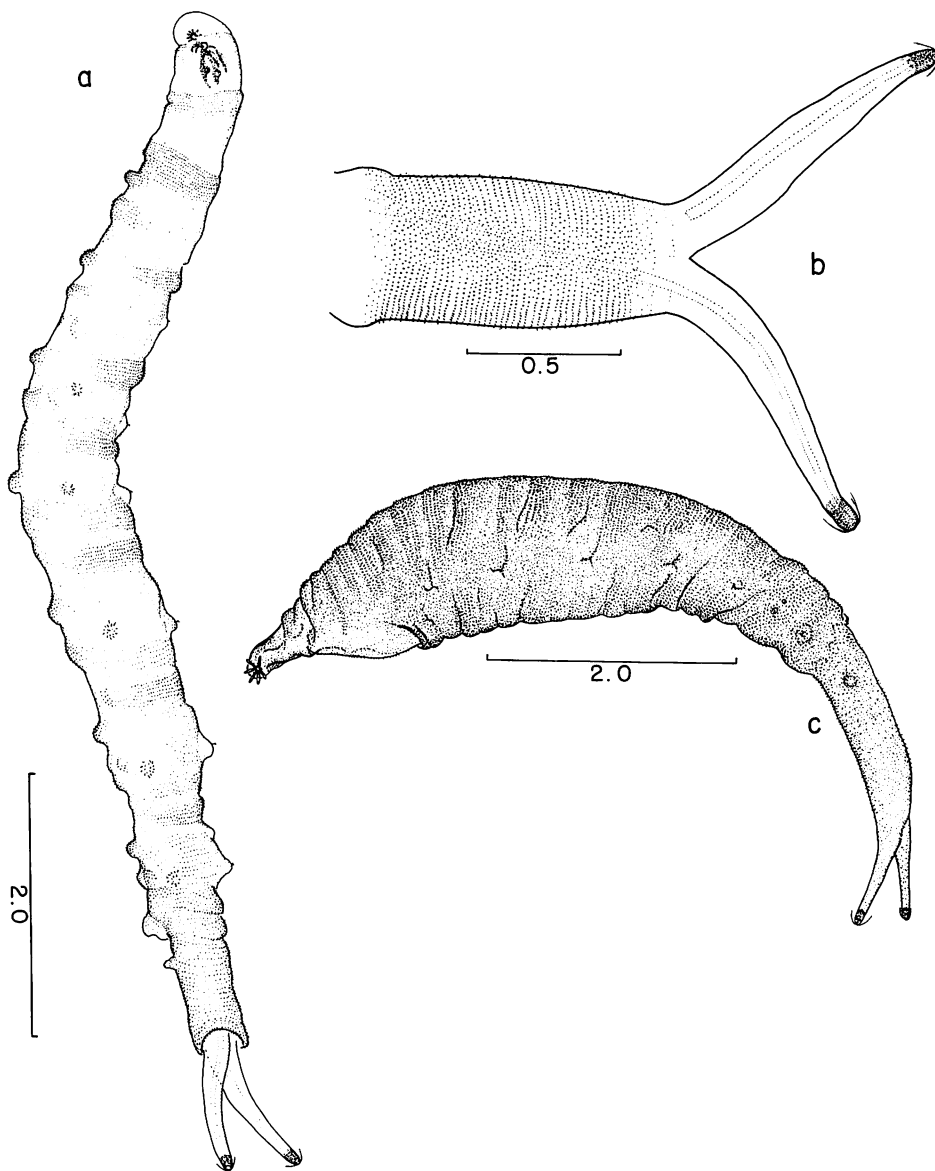


Figure 139—*Neoscatella sexnotata* (Cresson) (long form): a, larva, dorsolateral; b, larva, posterior spiracular tubes; c, pupa, lateral.

palmate hairs present (fig. 135e). Cephalopharyngeal skeleton as in figure 136a; mouthhooks from dorsal view as in figure 136b.

Puparia: Yellow-brown, as in figure 135a. Usually very broad medially, elongated anteriorly and posteriorly.

Immatures for morphological studies were obtained from laboratory rear-

ings. Adults were placed in a gallon jar partly filled with enough water to partially submerge the algae-covered rocks; thus, egg, larvae, and pupae were easily obtainable. Eggs are as described by Williams (1938:104).

***Neoscatella kauaiensis* Wirth (figs. 137a-c)**

Many pupae and one larva were collected at Waipoo Falls, Kauai (on rocks in swift stream). Dissected pupae were determined as *kauaiensis* and the associated larva assumed to be the same species.

Larval length about 5.1 mm., about seven times longer than wide; puparia about 3.2-4.6 mm. in length.

Larva and puparia: as in figures 137a,b. Body spines weaker than in *clavipes* and related species, stronger than in *hawaiiensis*. Anterior spiracles with four digits. Posterior spiracular tubes not retractile, covered with tiny spines which appear dot-like and form an irregular pattern (fig. 137c); the tubes spread at approximately right angles to the last body segment; four groups of palmate hairs are associated with the four spiracular openings.

The larva and puparia of *kauaiensis* are similar to those of *hawaiiensis* in having relatively small spines on the body and palmate hairs on the posterior spiracular tubes, but are like those of *clavipes* in having nonretractile spiracular tubes that are spined and not bare.

No rearings have been made of this species.

***Neoscatella oahuense* (Williams)**

According to Williams (1938:104), *N. oahuense* larvae have four spines on the apex of the posterior spiracular tubes in the first instar, one of the spines bristle-like. Williams illustrated a posterior spiracular tube with the three spines and one bristle (fig. 41b of Williams), and it is virtually identical to the armature found on *clavipes* larvae (3-spine form). Williams further states that these spines are replaced in the later instars by palmate hairs. That such a change takes place is extremely doubtful, and it is probable that Williams was working with a mixed series of larval specimens. This author has not been able to correlate any immatures with adults of *N. oahuense*, but most likely the posterior spiracular tubes bear palmate hairs in all larval stages, as is the case with other larvae of calm and standing water habitats.

***Neoscatella sexnotata* (Cresson) (figs. 138a-e, 139a-c)**

This species appears to have dimorphic larvae and pupae. A large number of larvae and pupae from Laysan Island appear to represent one form. The other form is widespread in the islands. Larvae and pupae of both forms were correlated with adults by dissection of mature pupae, as well as the capture of *sexnotata* adults along with the immatures.

Long form (fig. 139): Larvae, pupae, and adults were collected from a supersaline lagoon on Laysan Island. Larvae are very long and thin, ten to twelve times longer than wide, white to yellow. Rows of tiny spines are evident

intersegmentally, body hair otherwise inconspicuous. Dorsolateral warts conspicuous, often producing bump-like projections (fig. 139a). Anterior spiracles with six to seven digits. Posterior spiracular tubes bare, retractile, very long and slender (fig. 139b); tubes with four openings and four groups of palmate hairs. Puparium about two-thirds the length of mature larva, with comparably long spiracular tubes (fig. 139c).

The Laysan material also contained two pupae with short spiracular tubes fitting the description of the other form below.

Short form (fig. 138): This form was found to be numerous on Maui (Kanaha Pond) and Oahu, particularly in the Ala Wai Canal, Salt Lake, and Kaelepulu Pond.

The white larva is quite distinct from that of the long form described above. It is comparatively shorter (about 4 mm. in length) and broader, about seven times longer than wide at broadest point (fig. 138a). Spines on the larva are relatively stronger, more extensively distributed on the segments than in the above form; there are three plicae per segment; sensory warts are also evident. Anterior spiracles with five to six digits. Posterior spiracular tubes shorter and thicker than in the long form (figs. 138c,d), bare and retractile; four spiracular openings and four groups of palmate hairs present (fig. 138b). Puparium as in figure 138e.

A parasite, *Urolepis rufipes* (Ashmead) (Pteromalidae), was reared from the *sexnotata* collected in the Ala Wai Canal, Oahu. This same species was reared from *Ephydra milbrae* collected in the same location, but the individual parasites of *sexnotata* are consistently smaller in size than those from *E. milbrae*.

***Neoscatella warreni* (Cresson) (figs. 140a-d, 141a-e)**

Immatures of this species were correlated with adults by rearings and dissection of mature pupae.

Larvae and puparia: Somewhat larger in size than those of other stream species, the larva about 4.7 mm. in length. Appearing quite brownish in color because of numerous body spines; body spination most conspicuous laterally and on ambulatory warts (fig. 140a), generally more reduced than in *clavipes*. Anterior spiracles not projecting much beyond body wall, being partially withdrawn into the spiracular chamber; I have not been able to ascertain the number of digits present. The most distinctive feature of the larva and puparium is the posterior spiracular tubes which are stubby and have tiny but densely placed spinules (fig. 140d). Spiracular tubes bear four strong spines at apex, along with four spiracular openings. In the puparia, which are usually rather elongate and narrow (fig. 140b), the anus and surrounding area are distinctive, slit-like (fig. 140c). The spiracular tubes in puparia are variously orientated, sometimes twisted around each other depending on where and on what pupation took place.

Many pupae collected in the swift stream at Boiling Pots, Hawaii (in crevices of rocks), are slightly different from the pupae described above. The

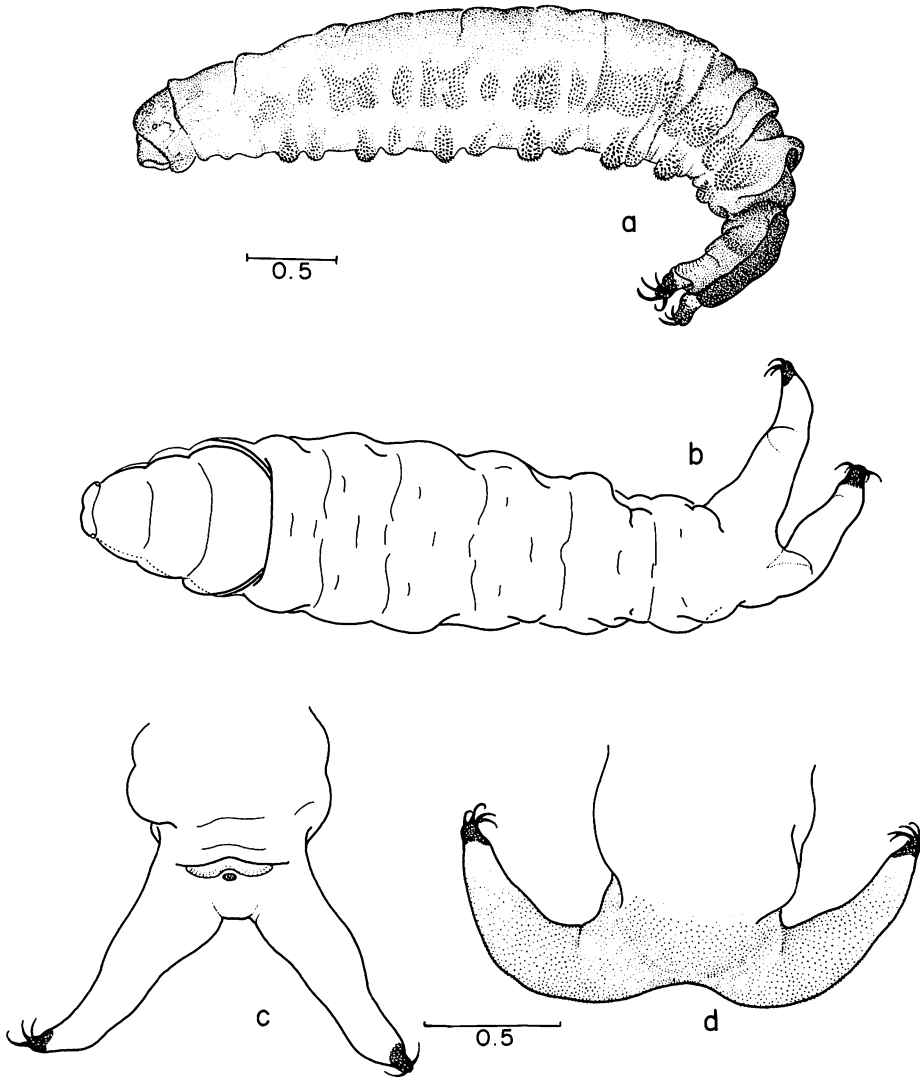


Figure 140—*Neoscatella warreni* (Cresson): a, larva, lateral; b, pupa, dorsal; c, pupa, posterior end, ventral; d, pupa, posterior end, dorsal.

puparium body (fig. 141a) and posterior spiracular tubes (fig. 141b) are stubbier, and the anus vent is very large and conspicuous (fig. 141c). However, mature pupae were dissected and found to be *warreni*.

Many pupae of the typical form were collected from Kahana Valley, Oahu, and both larvae and pupae in large numbers were collected from the following areas on Maui: Iao, Makamakaole, Kopiliula, and Palikea Streams. The larvae and pupae of this species, except for Kahana Stream on Oahu, are not as

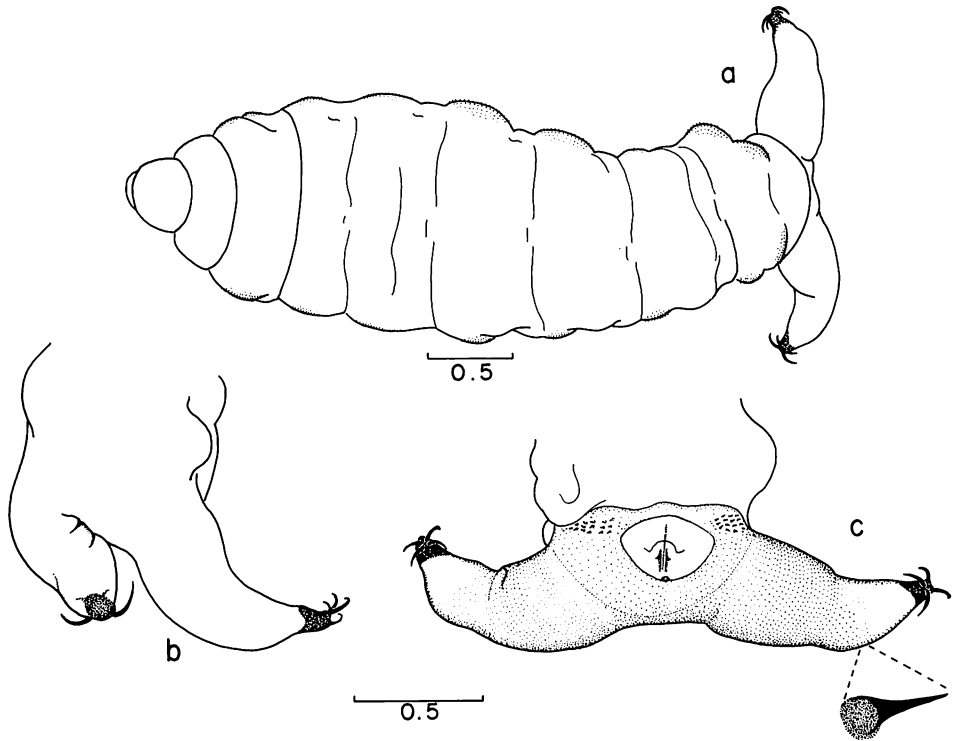


Figure 141—*Neoscatella warreni* (Cresson) (Hawaii): a, pupa, dorsal; b, pupa, posterior end, dorsal; c, pupa, posterior end, ventral.

easy to find as the other stream species, and are usually collected in small numbers with large collections of *clavipes* and *cilipes* larvae.

Williams (1938:106) published some interesting notes on *warreni* biology and illustrated the puparia (fig. 34 of Williams).

***Placopsidella cynocephala* Kertész (figs. 125a-e)**

Mature larvae and puparia about 4 mm. in length.

Larvae: White; body segments with lateral margins dorsally and ventrally expanded into pointed spines, these spines difficult to see in the white larva, but very conspicuous on puparium; smaller tubercles are present on dorsal and ventral surfaces of segments (fig. 125b). Anterior spiracles not externally evident in larva. Posterior spiracular tubes dorsoapical, very short, with three spiracular openings; four groups of palmate hairs border the openings, the hairs reaching to about the rim of the spiracular tube (fig. 125e). Cephalopharyngeal skeleton as in figure 125c.

Puparia: Yellow, spines as described for the larva, very evident on the

puparium (fig. 125a). Anterior spiracles conspicuous, borne on flattened disc, rimmed with about 14 to 15 digits (fig. 125d).

This species was easily reared in the laboratory using seaweed as a medium in gallon jars. Eggs hatched in about 24 hours; the larval period was eight to nine days; the pupal period was ten to thirteen days; and the complete life cycle from egg to adult required from 19 to 23 days.

Family MILICHIIDAE

Small, usually dull to shiny black flies, sometimes with the dorsum of male abdomen metallic silver. Rather closely resembling some Agromyzidae but differentiated by having the postocellar bristles parallel or convergent, not divergent; costa twice broken, rather than with only the break before end of Sc + R₁; mesopleura lacking bristles (in Hawaiian species); abdomen usually with only four visible terga (counting the fused basal portion as one); and female ovipositor rather weakly sclerotized and retractile (fig. 145d), not with the seventh segment heavily sclerotized, tubular, nonretractile.

In addition to the above, usually well-developed oral vibrissae are present. The front with bristles on almost the entire length of orbits, anterior fronto-orbitals convergent. Interfrontalia with two series of converging setae. Proboscis usually long and geniculate. Antennae short, third segment rounded. Subcosta weakly developed, not reaching costa, fused with R₁ before apex or ending at base of wing incision at second costal break in Hawaiian species. Cells M and Cu small. Abdomen short and broad with few, if any, bristles.

The adults are usually collected hovering in bright sunlight, or swarming over manure, decaying vegetation, freshly cut grass or freshly turned soil, or on vegetation in the sun. The larvae apparently feed largely as scavengers in manure and decaying organic matter. In other regions some species are blood sucking ectoparasites of birds; some live in close association with ants while others are associated with predatory insects and spiders. The biology of milichiids has been summarized by Sabrosky (1959:317).

The genital characteristics have been discussed by Hennig (1939b).

KEY TO HAWAIIAN MILICHIIDAE

- 1. Head narrow in lateral view, slightly rounded ventrally; genae narrow, scarcely equal to 1-2 rows of eye facets in width (fig. 146a). Mouthparts short, labella extending only slightly beyond palpi. Costa with a deep incision just before apex of Sc + R₁. Subfamily Milichiinae. 2
- Head comparatively broad, usually just slightly

- higher than long, ventral margin straight and genae well developed (fig. 145a). Mouthparts long and geniculate, usually about two times longer than palpi. Costa lacking a prominent incision before Sc + R₁. Subfamily Madizinae. 5
- 2(1). Hind margin of eye incised at middle (fig. 149a). Body and front subshining to polished black, or with dorsum of abdomen silvery. Two pairs of strong inferior fronto-orbital bristles. **Milichiella** Giglio-Tos. 3
 Eye not incised on hind margin. Front and body gray pollinose. No inferior fronto-orbital bristles, but with a pair of convergent interfrontal bristles just above antennae. **Milichia orientalis** Malloch.
- 3(2). Thorax, sides and apex of abdomen polished black; terga mostly opaque brown pollinose. Wings milky white. Halteres yellow. . . . **lacteipennis** Loew.
 Thorax subshining, gray-brown pollinose; dorsum of abdomen (male) brilliantly silvered. Wings not milky. Halteres black. 4
- 4(3). Abdomen of male entirely silvery above. Apices of terga sparsely setose, only one complete row on each of terga 3-5 or sometimes two irregular, incomplete rows on each. Each cercus with an elongate wavy bristle at apex (fig. 149b). **longiseta** n.sp.
 Abdominal terga marked with brown across apices. Apical half of fifth tergum and most of basal segment (1 + 2) rather densely setose. Terga 3-4 with two distinct rows of setae over apices. A short straight bristle on each cercus (fig. 147b). Oahu. **circularis** Aldrich.
- 5(1). Pteropleura lacking bristles. Arista pubescent. Hind tibiae may be flattened laterally, but not strongly expanded and much narrower than femora. 6
 Pteropleura with 1-2 short bristles. Front lacking the M-shaped mark. Arista bare. Hind tibia strongly flattened and expanded, about equal in width to femur, especially in the male (fig. 145c). **Leptometopa beardleyi** n.sp.
- 6(5). Front with a pair of gray interfrontal vittae marking

- off a velvety black M (fig. 142a). Hind tibiae compressed laterally. Crossvein r-m situated at middle of cell 1st M₂. **Desmometopa** Loew. 7
- Front entirely dull black. Hind tibiae not flattened. Crossvein r-m situated near apical three-fourths of cell 1st M₂. **Neophyllomyza** Melander, sp.?
- 7(6). Head higher than long (fig. 142b), not narrowed anteriorly in lateral view. Genae not with a polished black stripe below eye margin. Pleura with not more than a shining area on front portion of each sternopleuron. Palpi yellow to rufous except at apices. 8
- Head as long as high, narrowed anteriorly as seen from side (fig. 144c). Each gena with a polished black line along upper edge. Propleura and anterior portions of meso and sternopleura polished black. Palpi black except for narrow yellow bases. Middle and hind tarsi mostly yellow. **tarsalis** Loew.
- 8(7). Genae yellow, not densely gray pollinose; sternopleura with a shining area anteriorly. Tarsi yellow. Male palpi greatly enlarged (fig. 143c). 9
- Genae densely gray pollinose obscuring the ground color; mesonotum and scutellum gray with a golden or golden-brown sheen. Pleura entirely gray pollinose. Tarsi brown. Male palpi not enlarged. **inaurata** Lamb.
- 9(8). Genae of both sexes comparatively broad, about equal in height to the third antennal segment. Palpi of male rather slender, about four times longer than wide and not much wider than third antennal segment (fig. 143a).
- **singaporensis** Kertész.
- Genae narrower, scarcely three-fifths the width of third antennal segment. Male palpi very broad, about two times longer than wide and much wider than third antennal segment (fig. 143c).
- **tristicula** Hendel.

Subfamily MADIZINAE

Characterized by lacking an incision at second costal break in wing. Head only slightly higher than long (in Hawaiian species) with lower margin straight

and produced anteriorly, and genae well developed, equal in width to five or more rows of eye facets (fig. 143c). Labella elongate, equal in length to lower margin of head, and with the vibrissa rather weak compared to *Milichiinae* (figs. 146a, 149a).

Three genera occur in Hawaii: *Desmometopa* Loew, *Leptometopa* Becker, and *Neophyllomyza* Melander.

Genus **DESMOMETOPA** Loew

Desmometopa Loew, 1866, Berl. Ent. Z. (1865) 9:184. Type-species, *Agromyza m-atrum* Meigen, by subsequent designation (Hendel, 1903:251), = *sordida* (Fallén).

Members of this genus are differentiated from other small dull black flies in Hawaii by the shape of the head (fig. 142b), elongate, geniculate mouthparts, and by the presence of a velvety black M on the front (fig. 142a).

Four species occur in Hawaii.

There are many reports in the literature of *Desmometopa* living in close association with predaceous flies, bugs, and spiders (Ref. Hennig, 1937:16-17). Some have been observed to be phoretic in the adult stage on asilid flies and reduviid bugs riding along on the backs of their hosts until a prey is captured; "whereupon they proceed, in company with the predator, to sup the exudations from the wounds of the victim" (Colyer and Hammon, 1951:238). Some species feed in spider webs on the prey captured by the spiders; the latter habit has been observed in Hawaii.

The larvae are reported to feed as saprophytes and are especially associated with dung and carrion.

The collections of *Desmometopa* are preponderantly females; male specimens are very scarce.

***Desmometopa inaurata* Lamb (figs. 142a-d)**

Desmometopa inauratum Lamb, 1914, Trans. Linn. Soc. Lond. (2)16:363.

Type-locality: Seychelle Islands.

Common on all the main Hawaiian Islands from sea level to 4000 ft. Records in the University collection date back to 1947.

Immigrant. Widespread.

Biology. A scavenger, probably breeds in an assortment of rotting organic materials. They have been bred from chicken manure and from rotting snails. One specimen was reared from a larva found inside a *Drosophila* pupa in decaying *Cheirodendron* leaves (Mt. Kaala, Oahu).

This species fits near *ciliata* Hendel, but according to C. W. Sabrosky (pers. comm.) the two are distinct. It is differentiated from other Hawaiian *Desmometopa* by having the genae and pleura densely gray pruinose and the mesonotum and scutellum gray with a rather distinct golden or golden-brown sheen. Ground color of genae brown to black; palpi black apically and yellow

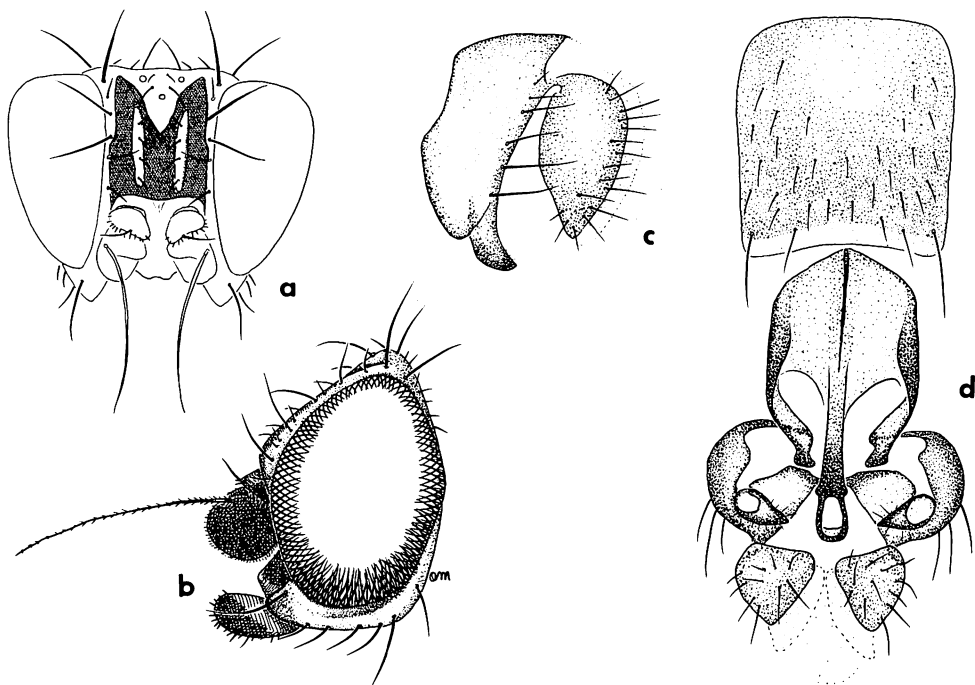


Figure 142—*Desmometopa inaurata* Lamb: a, head, frontal view; b, head, lateral; c, male genitalia, lateral; d, male genitalia, ventral.

to rufous basally, not enlarged in males; legs all dark, brownish to black; and male genitalia as in figures 142c,d. Fifth sternum of male longer than wide, hind margin straight. Surstyli sharp pointed. Head as in figures 142a,b.

Length: body and wings, 2.4–2.7 mm.

***Desmometopa singaporensis* Kertész (figs. 143a,b)**

Desmometopa singaporensis Kertész, 1899, Természetr. Fü. 22:194. Type-locality: Singapore.

Oahu, Hawaii, probably on other Hawaiian Islands.

Immigrant. Oriental region and probably widespread over southeast Asia and the Pacific.

According to C. W. Sabrosky (pers. comm.), the species we have been calling *palpalis* de Meijere in Hawaii (Hardy, 1952:474) is actually *singaporensis* Kertész; he has studied the type series. It was first recorded in Hawaii as *m-nigrum* (Zetterstedt) and later as *tarsalis* Loew, determined by Aldrich, reared from hen manure, March 1916 (Illingworth, 1926b, 1929b).

Mostly black, moderately gray pollinose species fitting near *tristicula* Hendel by having the palpi of the males greatly enlarged. Also, the genae yellow and the pleura gray except for a shining area on anterior portion of each ster-

nopleuron. It is differentiated from *tristicula* by having the genae of both sexes much broader, about equal in height to width of third antennal segment and the male palpi rather slender, about four times longer than wide, somewhat ensiform, ending acutely and not much wider than third antennal segment (fig. 143a). The palpi of the male specimens on hand are yellow, speckled with black. The fifth sternum of the male is as wide as long, with the hind

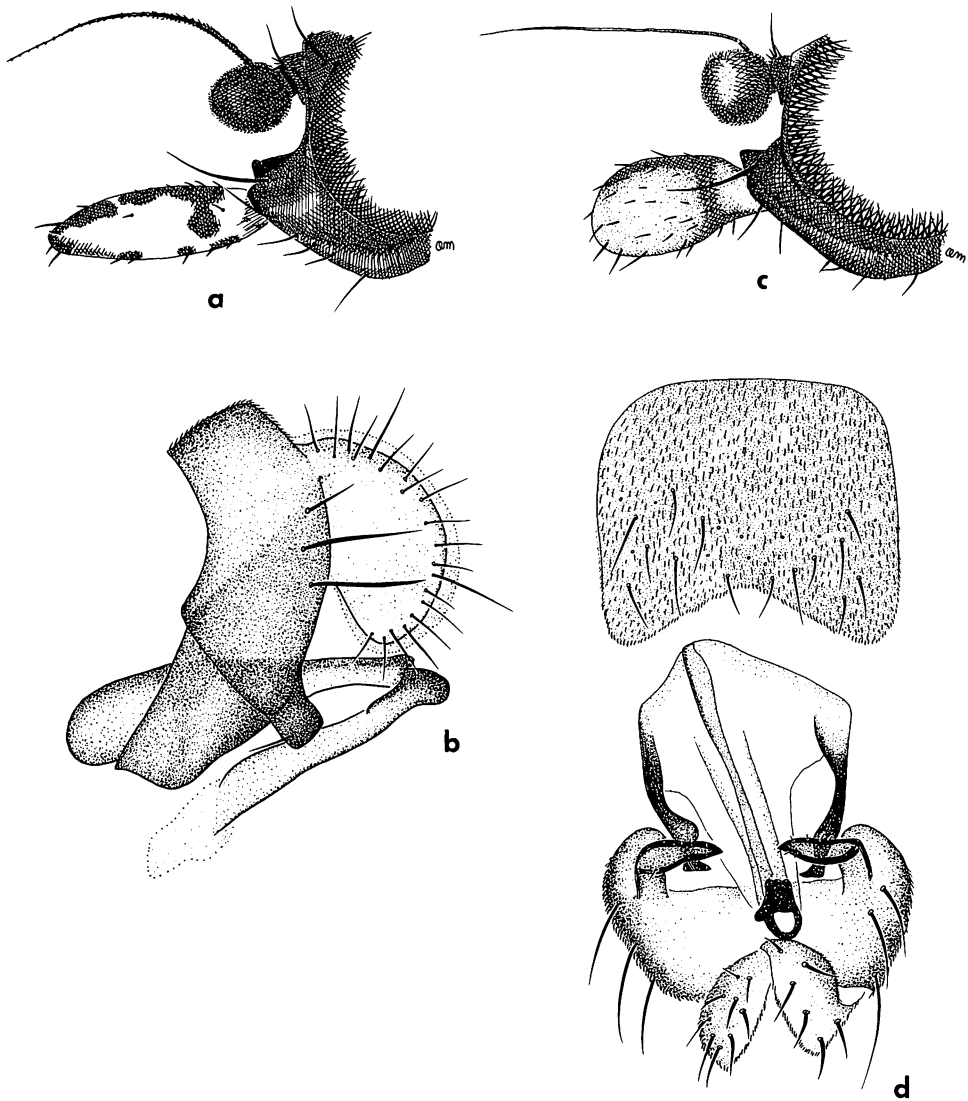


Figure 143—*Desmometopa singaporensis* Kertész: a, head, anteroventral portion; b, male genitalia, lateral. *D. tristicula* Hendel: c, head, anteroventral portion; d, male genitalia, ventral.

margin straight. The surstyli are slender, sharp pointed; the other details of the genitalia are as in figure 143b.

Length: body and wings, 2.5–2.7 mm.

***Desmometopa tarsalis* Loew (figs. 144a–c)**

Desmometopa tarsalis Loew, 1866, Berl. Ent. Z. (1865):184. Type-locality: Cuba.

Widespread over all of the Hawaiian Islands.

First recorded as *m-nigrum* (Zett.), reared from hen manure, on Oahu, March, 1916 (Illingworth, 1926b).

Immigrant. Nearctic, Cuba, West Indies, Panama.

Biology. A scavenger, it has been reared from chicken manure in Hawaii.

This species has probably been commonly misidentified in the literature. The concepts of Hennig (1937:44), Hendel (1914:96), Bezzi (1928:162) probably refer to a complex of species.

Predominantly subshining black flies, characterized from other Hawaiian species by having the head about as long as high, narrowed anteriorly as seen in lateral view, with the lower margin elongate, equal in length to eye width and strongly produced anteriorly (fig. 144c); by having the genae narrow, black, gray pollinose with a polished black line on upper edge, along eye

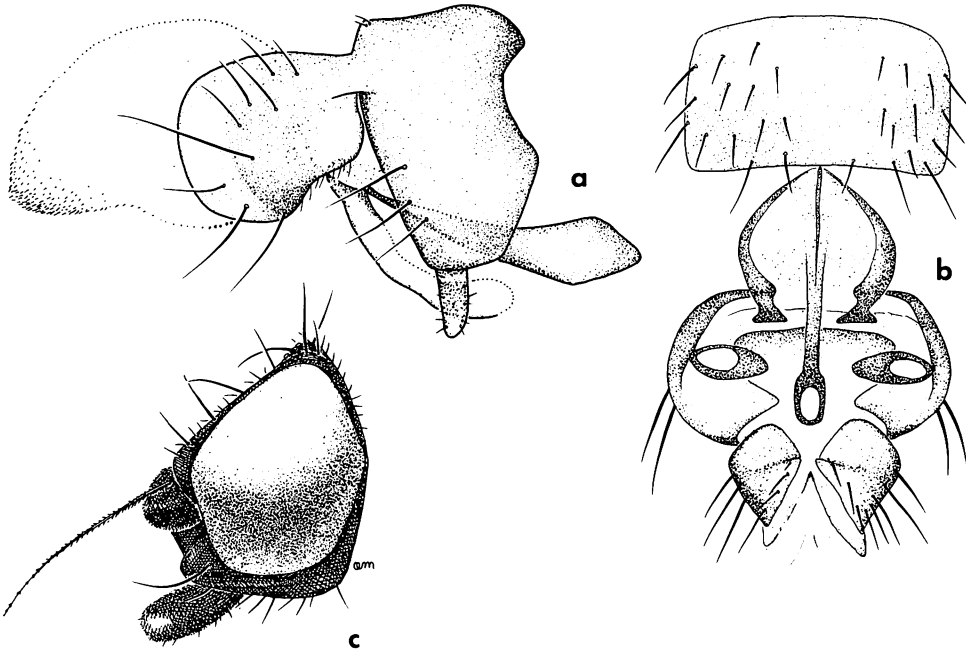


Figure 144—*Desmometopa tarsalis* Loew: a, male genitalia, lateral; b, male genitalia, ventral; c, head, lateral.

margin; by having a large polished black area over propleura and anterior portions of meso and sternopleura. The palpi black except for narrow yellow bases. Middle and hind tarsi mostly yellow. Fifth sternum of male wider than long and male genitalia as in figures 144a,b.

Length: body and wings, 2.2–2.4 mm.

Desmometopa tristicula Hendel (figs. 143c,d)

Desmometopa tristicula Hendel, 1914, Suppl. Ent. 3:96. Type-locality: Anping, Formosa.

Oahu, Kauai, and probably other Hawaiian Islands.

Immigrant. Apparently widespread over Pacific and Oriental regions.

Along with *singaporensis* this species has previously been determined as *palpalis* de Meijere in the Hawaiian literature.

Resembling *singaporensis* Kertész and differentiated by having the genae of both sexes comparatively narrow, scarcely three-fifths the width of the third antennal segment. Palpi of male very broad, expanded about twice as long as wide, rounded apically, and much broader than third antennal segment (fig. 143c). The male genitalia are as in figure 143d.

Genus **LEPTOMETOPA** Becker

Leptometopa Becker, 1903, Berl. Zool. Mus. Mitt. 2(3):188. Type-species, *rufifrons* Becker, by monotypy.

Hypaspistomyia Hendel, 1907, Wien. Ent. Ztg. 26:2401. Type-species, *coquilleti* Hendel, by monotypy.

Paramadiza Malloch, in Melander, 1913, Psyche, Camb. 20:169. Type-species, *Desmometopa halteralis* Coquillett, by monotypy.

Mallochiella Melander, 1913, Psyche, Camb. 20:169 (new name for *Paramadiza* Malloch). Type-species, *Desmometopa halteralis* Coquillett.

Desmometopina Curran, 1930, Bull. Amer. Mus. nat. Hist. (1931) 61:81. Type-species, *Agromyza latipes* Meigen, by original designation.

Only one species known, from the Leeward Hawaiian Islands.

Characterized from other Madizinae by having one or more small bristles on the pleurotergon; hind tibiae strongly flattened especially in the male (fig. 145c); epistoma broad and triangular; arista bare, in the Hawaiian species; front comparatively narrow, distinctly longer than wide, no interfrontal stripes and no M-shaped mark; also, the genae are consistently broad, equal to one-third or less the eye height and length (fig. 145a).

The larvae of some *Leptometopa* have been discussed by Hennig (1956).

Only one species known from the Hawaiian Islands.

Leptometopa beardsleyi Hardy and Delfinado, **new species** (figs. 145a–e)

Leptometopa n.sp. (det. by C. W. Sabrosky) Beardsley, 1966, Proc. Haw. Ent. Soc. 19(2):178. First recorded from Lisianski, Nihoa, Necker

Islands and from Pearl and Hermes Atoll, 1962 and 1964.

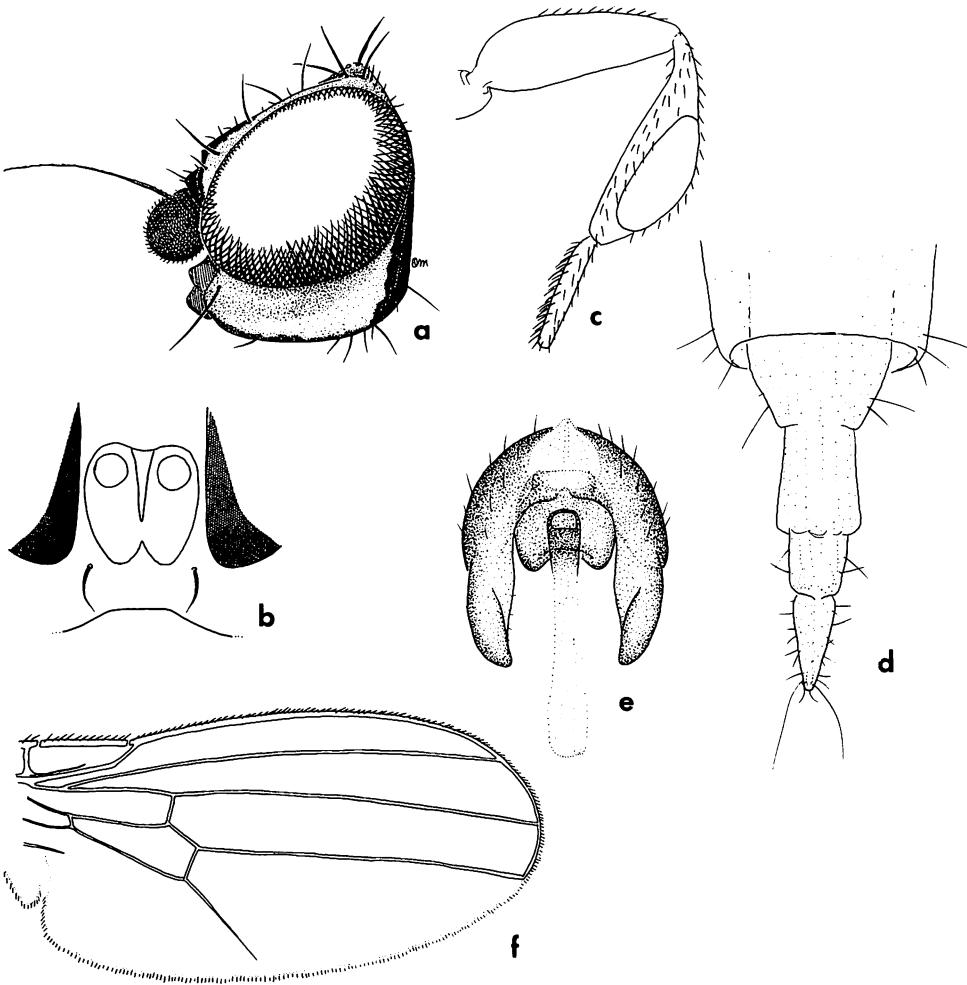


Figure 145—*Leptometopa beardsleyi* Hardy and Delfinado, n. sp.: a, head, lateral; b, face; c, hind leg; d, female ovipositor; e, male genitalia, ventral. *Neophyllomyza* sp?: f, wing.

This species runs to *coquilletti* Hendel (1937:48) and the head shape and general characteristics conform rather well with that species. It is readily differentiated by the all-black legs; the genae black in ground color completely silvery pollinose in the male, rather than having the lower margins of the genae rufous; the femora reddish-brown and the tibiae yellow. Also by having the scutellum gray pollinose, rather than polished black. The predominantly polished black pleura is also a diagnostic feature.

MALE. Head: Slightly higher than long, with the eyes almost circular and the genae broad, about one-third the height, or the length, of the eye (fig. 145a). The gena is entirely silvery pollinose (microscopically pubescent), except for a narrow strip immediately beneath the eye margin and for the upper posterior

edge bordering on the occiput. The oral vibrissae are represented by fine, rather inconspicuous setae along the oral margin. One prominent bristle is present on anteromedian margin of each gena. Two pairs each of superior and inferior fronto-orbital bristles present, the superior directed upward over the eyes with the upper slightly proclinate; the inferiors are directed inwardly. Front dark brown to black, tinged faintly with rufous in ground color on lower portion, subopaque, covered with dark brown pollen through median portion, silvery-gray along eye orbits. Ocellar bristles well developed, approximately equal in size to fronto-orbitals, postocellars just slightly smaller. The lunule (the portion of the face below the ptilinal suture) and the epistoma are yellow; the former is extended into a slender spine-like projection (keel) between the antennae (fig. 145b). The remainder of face is deeply sunken, yellow brown in color. Palpi yellow, tinged with brown at extreme apices and with a few stout setae on ventral margins and apices. Rostrum mostly black, labella tinged faintly with rufous and about equal in length to palpi. *Thorax*: Mesonotum and scutellum densely gray pollinose, with no indication of brown markings. Two pairs dorsocentral bristles, the posterior pair large, almost equal in size to outer post-alars, and with anterior pair small, only two-three times longer than the mesonotal setae, and located in line with the supraalars. Supraalars rather small, about equal to inner postalars. One small black bristle, about equal to anterior dorsocentrals, located in median portion of each pteropleuron. Sternopleuron with one black bristle on upper median margin. Pleura polished black except for gray pollen, microscopic pubescence over hind portion of each pteropleuron, upper hind and ventral portions of sternopleuron, and all of the meta and hypopleuron. Halteres with bright yellow knobs and rufous stems. *Legs*: Entirely black. Hind tibia rather strongly enlarged, convex on posterior margin and equal to slightly wider than the femur (fig. 145c). *Wings*: Milky white, with yellow veins and with the venation rather similar to most species of *Desmometopa*. The r-m crossvein is located approximately opposite the second costal break and at about median portion of cell 1st M_2 . The m crossvein is located near basal two-fifths of the wing. The last section of vein $M_3 + 4$ is almost three times longer than m crossvein and evanesces before reaching margin. The last section of vein $M_1 + 2$ is very slightly upcurved toward apex. *Abdomen*: Black in ground color, gray-brown pollinose over most of the dorsum, polished black on extreme lateral margins of terga 3-5 and over apical portion of 5. The surstyli are broad and blunt, rounded at apices, about equal in length to epandrium. Other details of the genitalia as in figure 145e.

Length: body, 1.8-2.0 mm.; wings, 1.7 mm.

FEMALE. Fitting the description of male in most respects. With the genae slightly more broad, each is approximately two-fifths the eye height and silvery-gray only on anterior margin; remainder of the gena is submetallic, bronze-brown. The hind tibiae are not so enlarged as in male, slightly less than the width of the femur. Fifth tergum entirely polished except for narrow basal margin. Female ovipositor as in figure 145d.

Length: body, 2.5 mm.; wings, 2.2 mm.

Holotype male and allotype female, Lisianski Island, sweeping, September 18, 1964 (J. W. Beardsley). 86 paratypes, 64 males, 22 females from the following Leeward Hawaiian Islands, the majority of specimens same data as type: Nihoa, June 10, 1962, on *Portulaca*, and September 23-24, 1964; Southeast I., Pearl and Hermes Reef, September 16, 1964; and Necker September 23, 1964, all collected by J. W. Beardsley. This species very probably breeds in bird guano.

Type, allotype, and the majority of paratypes in the B. P. Bishop Museum. Paratypes deposited in the collections of the U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

Genus **NEOPHYLLOMYZA** Melander

Neophyllomyza Melander, 1913, J. N.Y. Ent. Soc. 21:243. Type-species, *quadricornis* Melander, by original designation.

Fitting nearest to *Desmometopa* than to any other Madizinae known from Hawaii. It is readily differentiated by having the front entirely dull black; the hind tibiae not flattened laterally and crossvein r-m situated near apical three-fourths of cell 1st M_2 . Also, the cubital cell is incomplete (fig. 145f) and the genae are very narrow with the eyes higher than long.

One unknown species recorded from Hawaii.

Neophyllomyza unnamed species (fig. 145f)

Two specimens on hand collected at Honolulu, Oahu, May 2-20, 1961-1965 (C. R. Joyce and J. W. Beardsley), was identified by C. W. Sabrosky as *Neophyllomyza* sp. This is differentiated from other Milichiidae in Hawaii by the characters given under the discussion of genus above. It is a small, completely black species including the halteres and all of the body appendages. In Melander's key (1914:243) it would run nearest to *quadricornis* Melander from the mainland U.S. except that the penultimate section of the fourth vein ($M_1 + 2$) is extremely short, only about one-seventh as long as the ultimate section and about one-third as long as the last section of vein $M_3 + 4$ (fig. 145f). Also, the description says the mesonotum, as well as front, is sericeous black. In our specimens the mesonotum is subshining, rather lightly gray-brown pollinose, not noticeably sericeous.

Further specimens will have to be collected before this species can be placed.

Length: body, 1.25 mm.

Subfamily MILICHIINAE

Characterized by having a deep cleft formed at the second costal break with vein Sc ending on inner edge of cleft and the lobe formed by the incision overlapping base of R_1 . Head much higher than long, with genae very narrow, scarcely visible in lateral view (in Hawaiian species), and equal in width to 1-2 rows of eye facets. Labella short, inconspicuous, fleshy.

Two genera have been recorded from Hawaii, *Milichia* Meigen and *Milichiella* Giglio-Tos.

Genus **MILICHIA** Meigen

Milichia Meigen, 1830, Syst. Besch. europ. Zweifl. Ins. 6:131. Type-species, *speciosa* Meigen, by subsequent designation (Westwood, 1840:151).

Lobioptera Wahlberg, 1847, K. Svenska Vet.-Akad. Ofvers.-Förh. 4:259. Type-species, *ludens* Wahlberg, by monotypy.

Characterized by having the hind margin of the eye straight, not incised and the postocellar bristles convergent, usually cruciate. Also, in the Hawaiian species, with no strong inferior fronto-orbital bristles, with the bristles of the vibrissal rows extending only to lower margin of face (fig. 146a), and the body densely gray and brown pollinose.

Only one known species in Hawaii.

Milichia orientalis Malloch (figs. 146a,b)

Milichia orientalis Malloch, 1913, Insecutor Inscit. menst. 1:109. Type-locality: Guam.

Oahu, Hawaii, Nihoa, Necker, and Gardner islands. First recorded from Oahu, March, 1915 (Bryan, 1923b:290).

Immigrant. Guam.

Biology. Specimens were bred from barley seed by Illingworth (Bryan 1923b:290) and from "swiftlet guano which was composed almost entirely of dry insect fragments, and from a mixture of rodent food and rodent droppings" on Guam (Bohart and Gressitt, 1951:98).

An all black, moderately gray pollinose species separated from other Hawaiian species by the generic characters given above. The head, from lateral view, is as in figure 146a. The fifth sternum of the male is longer than wide with a rather deep concavity in middle of hind margin. Male genitalia as in figure 146b.

Length: body, 3.0-4.0 mm.; wings, 2.75-3.2 mm.

Genus **MILICHIELLA** Giglio-Tos

Milichiella Giglio-Tos, 1895, Ann. Soc. Ent. Fr. 64:367. Type-species, *Tephritis argentea* Fabricius, by monotypy. Misidentified, = *tosi* Becker.

Ophthalmomyia Williston, 1896, Trans. Ent. Soc. Lond. 1896:426. Type-species, *Lobioptera lacteipennis* Loew, by monotypy.

Readily differentiated by the prominent incision in the hind margin of the eye (fig. 149a) and by the parallel postocellar bristles. In the Hawaiian species the inferior fronto-orbitals are strong and the bristles of the vibrissal rows extend over the lower half to three-fifths of the face.

Three species occur in Hawaii.

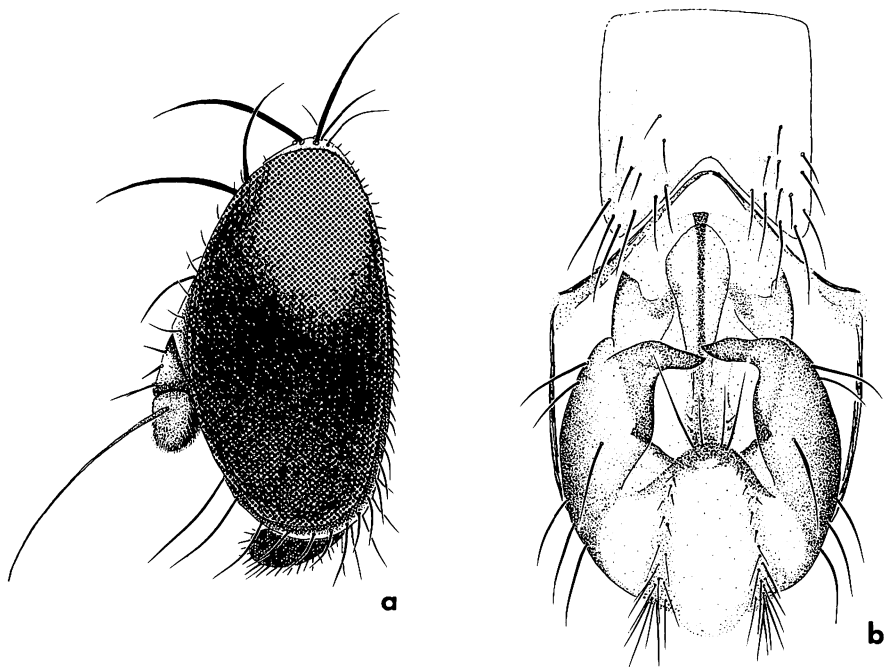


Figure 146—*Milichia orientalis* Malloch: a, head; b, male genitalia, ventral, showing fifth sternum.

***Milichiella circularis* Aldrich (figs. 147a,b)**

Milichiella circularis Illingworth, 1929, Proc. Haw. Ent. Soc. 7:254 *Nomen nudum*.

Milichiella circularis Aldrich, 1931, Proc. Haw. Ent. Soc. 7:397. Type-locality: "pineapple fields in Hawaii."

Endemic? Oahu. First collected in September, 1926.

Biology. Probably a scavenger, breeding in decaying vegetation. It has been collected near compost piles. Known only from males, collected in swarms.

Characterized by having the abdomen of the male predominantly silvery on the dorsum but opaque brown on apices of terga 3-5 and over median portion of 1 + 2. Also, the arrangement of the setae on the terga is distinctive: the first tergum (1 + 2) is mostly setose; 2 and 3 have two distinct rows across apices and 5 is rather densely setose over apical half. Each cercus has a straight black bristle at apex; this is short compared to *longiseta* n.sp. (figs 147b, 149b). The other genital characters are as in figure 147b. The fifth sternum is about as long as wide and has a shallow concavity on hind margin (fig. 147a). The fourth sternum is one-fourth longer than wide and gradually narrowed basally.

Female. Unknown.

Length: body, 3.5-4.0 mm.; wings, 3.0-3.25 mm.

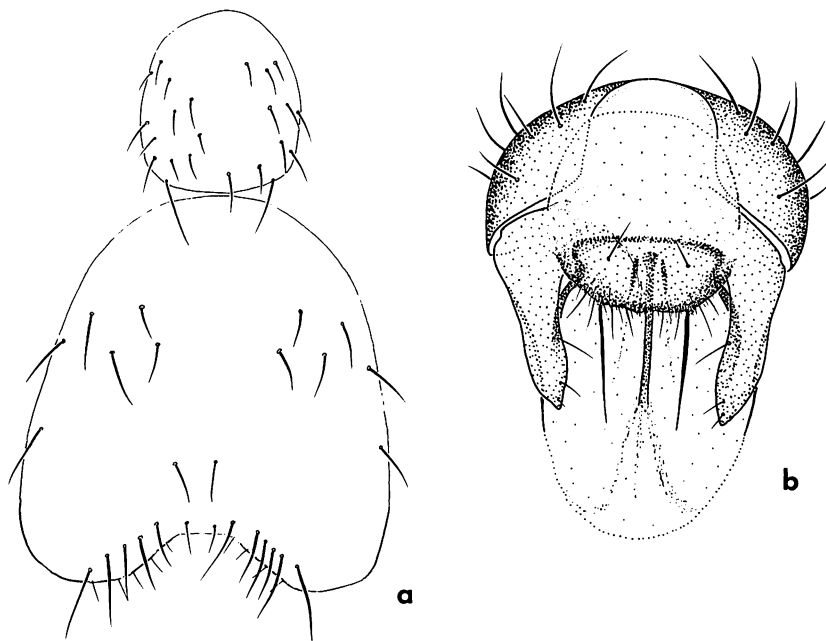


Figure 147—*Milichiella circularis* Aldrich: **a**, fifth sternum of male; **b**, male genitalia, dorsal.

***Milichiella lacteipennis* (Loew) (figs. 148a,b)**

Lobioptera lacteipennis Loew, 1866, Berl. Ent. Z. (1865) 9:185. Type-locality: Cuba.

Milichiella nigrella Cole, 1912, Ann. Rpt. Laguna Mar. Lab. 1:162. Type-locality: California.

Common on all of the Hawaiian Islands, including Kure, Laysan, Midway, Pearl and Hermes Reef, and probably other Leeward Islands. First recorded from Hawaii by Grimshaw (1901:74) as *Ophthalmomyia*, specimens collected by Perkins, Kona, Hawaii, August–September, 1892.

Immigrant. Widespread over Nearctic, Neotropical, Ethiopian, Oriental, Australian, and Pacific regions.

Biology. Evidently a scavenger: adults are common around manure and decaying organic matter. It has been bred from poultry manure on Oahu and from Guinea pig dung in Samoa (Malloch 1934b:326). Adults have been observed attracted to the Pentatomid bug, *Nezara viridula smaragdula* (Fab.) (Nakao, 1964).

The most common of *Milichiella*, easily recognized by the milky white wings; yellow halteres; and by having the thorax and sides and apex of abdomen polished black, and the abdominal terga mostly opaque brown pollinose and lacking silvery markings. Fifth sternum of male over two times longer than

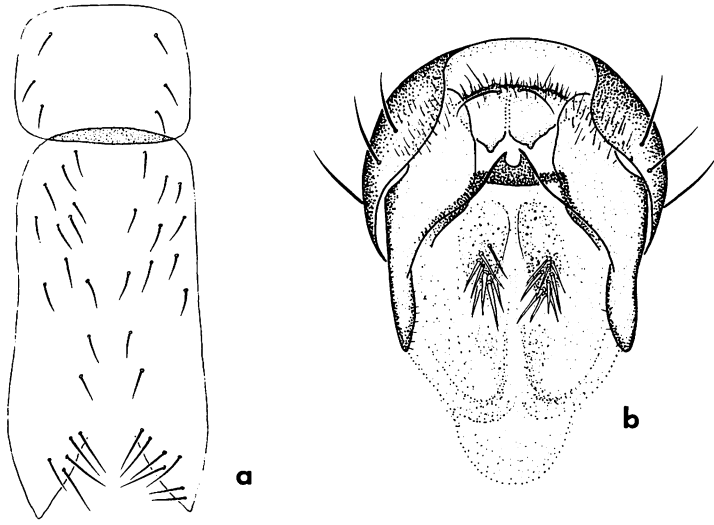


Figure 148—*Milichiella lacteipennis* (Loew): a, fifth sternum of male; b, male genitalia, dorsal.

wide, with a deep, narrow cleft in middle of hind margin (fig. 148a). Genitalia as in figure 148b.

Length: body, 3.5 mm.; wings, 3.0 mm.

***Milichiella longiset*a Hardy and Delfinado, new species (figs. 149a–c)**

Belonging in the group of species which have the male abdomen entirely silvery on the dorsum. Differentiated from *circularis* Aldrich by the characters given under the latter species and in the key. It fits near *bakeri* Aldrich from the Philippines but that species has the calypters black with brown hairs, etc.

MALE. Mostly black species except for the silvery dorsum of abdomen. **Head:** Shaped as in figure 149a. Three pairs inferior fronto-orbital bristles, the lower two pairs convergent, the upper pair proclinate. One pair of reclinate superior fronto-orbitals. The oral vibrissae continuous as a row up each side of lower two-thirds of face, along eye orbit. Front dull black except for a shining black line along each orbit and a narrow shining line down middle from lower ocellus nearly half the length of front, front rather strongly narrowed anteriorly. Antennae and palpi black, third segment of antenna brown, rather small, arista microscopically pubescent. Palpi with numerous black setae around apical margin. **Thorax:** Shining black in ground color, lightly gray-brown pollinose. The chaetotaxy is similar to that of other members of this genus, but the setae on the mesonotum are much stronger, more developed than *circularis*; a row of moderately strong bristle-like setae occurs from presutural bristle to dorsocentral row; these are approximately three times longer than surrounding setae; also one other enlarged seta nearly two times longer than others is

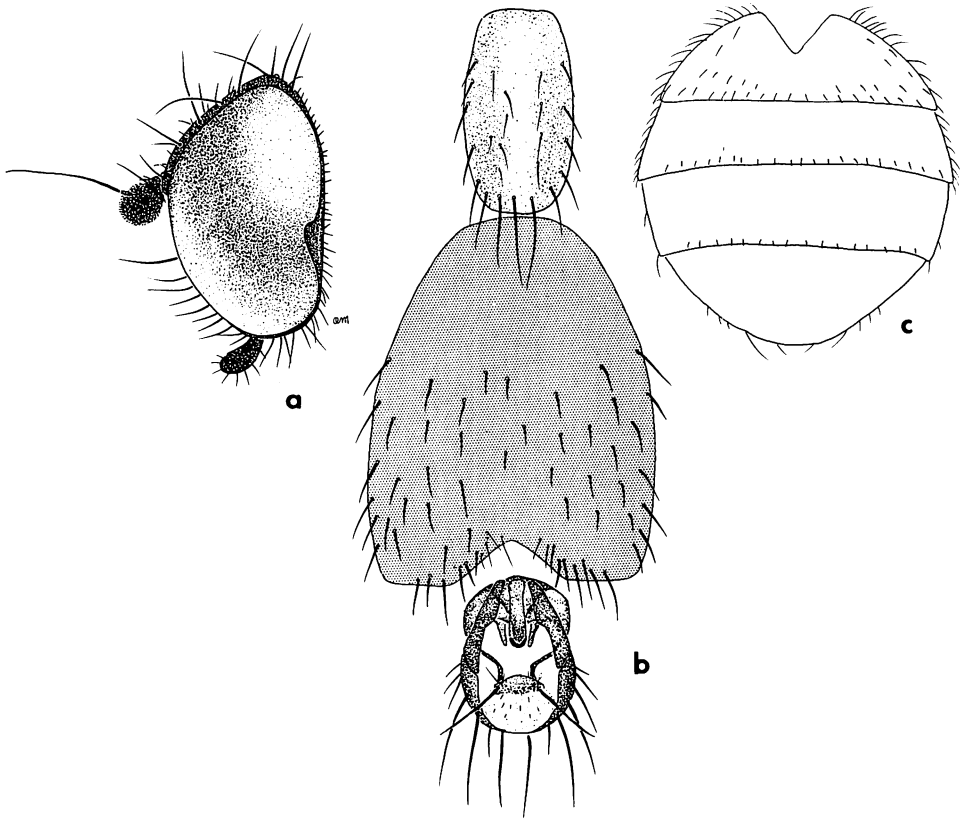


Figure 149—*Milichiella longiseta* Hardy and Delfinado, n. sp.: a, head; b, post abdomen of male, ventral; c, male abdomen, dorsal.

present in dorsocentral row behind suture. *Legs*: Black with a tinge of yellow on tarsi. *Wings*: Subhyaline, lightly fumose, venation similar to that of other *Milichiella*, with veins $R_4 + 5$ and $M_1 + 2$ slightly converged at apices. Calypters gray, margin brownish fringed with yellow hairs. *Abdomen*: Very broad, only slightly longer than wide and somewhat flattened on dorsum with entire upper portion brilliant silvery. First tergum sparsely setose on lateral margins with two or three irregular rows of setae extending over posterior lateral margins, reducing to one irregular row across median hind margin (fig. 149c). Terga 3-5 with only one complete row of black setae across hind margin, sometimes with two irregular, incomplete, rows. The fifth sternum is longer than wide, with a broad V-shaped cleft in middle of hind margin. Each cercus has a strong, slightly wavy bristle at apex; this is nearly three times longer than epandrium. The surstyli are enlarged, rounded at apices. Other details of the genitalia are as in figure 149b.

Length: body, 3.7 mm.; wings, 3.0 mm.

FEMALE. Unknown.

Holotype male, Honolulu, Oahu, September, 1951, sweeping (J. W. Beardsley). 47 paratypes, mostly collected swarming in bright sunlight from the following localities on Oahu: same as type, collected throughout most of the year, 1951–1968 (J. W. Beardsley, M. D. Delfinado, D. E. Hardy, J. Ikeda, S. Tanaka, R. H. Oshiro); hills behind Dillingham Air Force Base, November, 1970 (W. Gagné); and Kalihi, May, 1956 (H. Lau).

Type and paratypes in B. P. Bishop Museum. Paratypes also deposited in the U.S. National Museum, British Museum (Natural History), and University of Hawaii collection.

Family CRYPTOCHETIDAE

A small family of flies, about 16 known species for the world, which are important biological control agents. All of the species are parasitic upon scale insects of the family Margarodidae, subfamily Monophlebinae. They are readily differentiated by lacking aristae, having the third antennal segment very large (fig. 150a), large scutellum, short abdomen and short, broad wings (fig. 150b). The costa is broken near humeral crossvein and at apex of subcostal vein. Subcosta complete, extending to margin free of R_1 , but faint. Cell Cu complete but cell M not closed. Front, vertex, mesonotum, and scutellum densely covered with short, erect setae and the bristles scarcely, if at all, differentiated.

Only one known genus, *Cryptochetum* Rondani.

Refer to Thorpe (1931) for a review of the family: taxonomy, biology, and economic importance. Also to Harrison (1959:328) for a discussion of family characters.

Genus CRYPTOCHETUM Rondani

Cryptochetum Rondani, 1875, Bull. Soc. ent. ital. 7:167 (as *Cryptochaetum*, p. 172). Type-species, *grandicorne* Rondani, by original designation.

Cryptochaetum; emend.

Lestophonus Williston, 1888, Insect Life 1:21. Type-species, *iceryae* Williston, by monotypy.

The only included genus, differentiated by the family characters given above.

It seems evident that the adults of certain species may be attracted to the eyes of large animals, and may possibly be of medical and veterinary importance in some areas. Lefroy (1909:633) reported an unknown species as being a very annoying fly in the jungle at Pusa, South India. A similar note is made by Bezzi (1919:241) concerning *C. fastidiosum* Bezzi in the Philippines. The label on the lectotype female of this species (ref. Delfinado, 1969:173) reads "Panay, Culasi/ May 1918/ McGregor/ in forest 500–1000 m./ a pest, flies into the inner corner of a person's eye." The authors found these flies extremely pestiferous in the mountains of Luzon and Mindanao at elevations of

2000–3000 ft. They fly directly into one's eyes and at times were so bothersome that it was impossible to collect. No investigations have been made to see if these flies are involved in transmitting eye infections among the hill tribes living in these areas.

Only one species occurs in Hawaii.

***Cryptochaetum iceryae* (Williston) (figs. 150a,b)**

Lestophonus iceryae Williston, 1888, Insect Life 1:21 (female). Type-locality: (Adelaide), Australia.

Cryptochaetum iceryae (Williston), Mik, 1889, Wien. Ent. Ztg. 8:281.

Oahu, Kauai, Hawaii, probably on all the main islands.

Immigrant. Australia, California, and New Zealand. First collected in a light trap in Honolulu by Beardsley, July, 1966, and subsequently reared from cottony-cushion scale, *Icerya purchasi* Mask, in 1967 (Hale, 1968) and later by Beardsley. The biology, postembryonic development, and economic importance of this species has been studied by Thorpe (1931). It was introduced from Australia to California in 1888 for control of cottony-cushion scale and Thorpe reported that it is potentially almost as efficient in control of the scale as the *Vedalia* beetle. Dr. D. Hale (unpublished thesis) found 50–60% of the scales in some areas on Oahu parasitized by *C. iceryae*.

Small metallic blue-black flies differentiated from other members of this genus by having a minute spine at apex of third antennal segment (fig. 150a); vein R_1 distinctly angulate; r-m crossvein proximal to the end of R_1 ; and m crossvein slightly curved. The head is about two times higher than long and the third antennal segment almost as long as face. Frontal triangle very large,

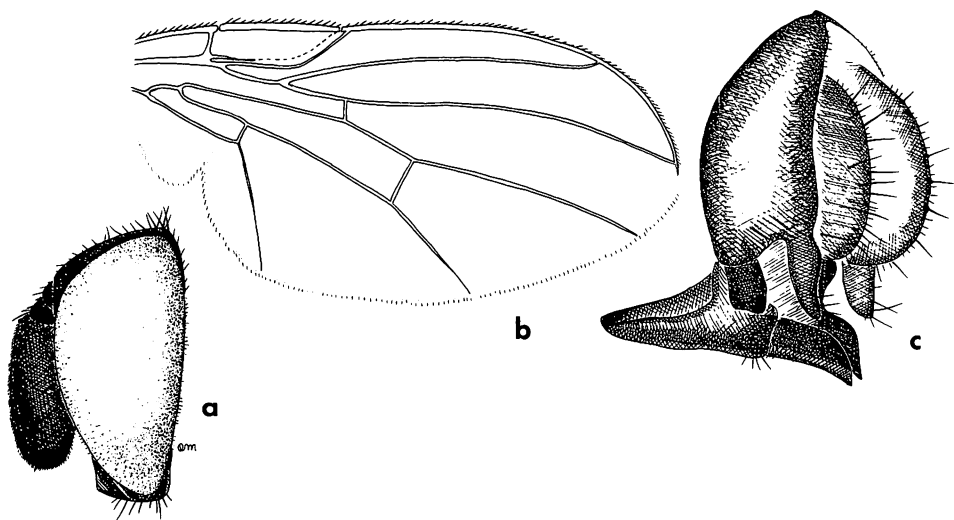


Figure 150—*Cryptochaetum iceryae* Williston: a, head, lateral; b, wing; c, male genitalia.

occupying almost entire front; the apical portion is blunt. Antennae widely spaced, the distance between bases is as wide as apex of frontal plate. Front polished black with a faint blue sheen; face silvery pubescent, metallic-blue in background. Genae very narrow, lower margin of each eye extending almost to oral margin. Front, dorsum of thorax, and abdomen rather densely covered with short, brown setae. Compound eyes short setose. Scutellum about half as long as mesonotum. Wings hyaline, about two times longer than wide; venation as in figure 150b. Legs brown to black, tarsi yellow tinged with brown. Male terminalia basically similar to those of Celyphidae. Cercus very narrow, rounded posteriorly with numerous short setae; epandrium narrowed dorsally and broken on dorsomedian margin; surstylus small, with thumb-like process a few fairly long setae apically, fused with epandrium; hypandrium with a well-developed and sclerotized plate, deeply cleft medianly, narrowed posteriorly and with dentate tips, with a few short hairs; aedeagus almost hyaline, pointed distally. Female with one small, rounded spermatheca.

Length: body and wings, 1.5–2.0 mm.

Family TETHINIDAE

Small, usually dark-colored, rather slender flies which are predominantly found on the seashore. They are differentiated from other acalypterate flies, which have the subcostal vein incomplete or vestigial and the costa broken only at end of Sc, by having presutural dorsocentral bristles present; the post-ocellar bristles convergent; fronto-orbital bristles directed outward; tibiae lacking preapical dorsal bristles; cell Cu complete; oral vibrissae present (although weak in *Pelomyia* Williston); and only one sternopleural bristle developed. They are similar in many respects to Trixoscelididae but are separated by the incomplete Sc, costa not spinulose, and tibiae lacking preapical dorsal bristles.

No biological data are available on the Tethinidae. Of the three genera which occur in Hawaii, *Tethina* Haliday and *Dasyrhicnoessa* Hendel species are restricted to the seacoasts (although occasional specimens have been collected in the high-lands, probably blown up by winds), and obviously breed in algae and other plant materials on the beaches. *Pelomyia* in other areas are usually found inland, associated with alkaline areas. We have no information on this in Hawaii.

For a revision of the family refer to Melander (1952) and to Hendel (1934) and for a discussion of the male genitalia to Hennig (1939b).

Dr. J. R. Vockeroth, Canada Department of Agriculture, has studied a series of specimens from our collection and has given us the background information needed to straighten out the taxonomy of the Hawaiian species.

KEY TO TETHINIDAE KNOWN FROM HAWAII

1. Front with three pairs of fronto-orbital bristles and several bristles and setae on interfrontal area.

- Genae bare of setae but with strong oral vibrissae (fig. 151a). Four to six rows of acrostichal setae present. Cell M separated from cell 1st M_2 (fig. 151e). 2
- Only one pair of fronto-orbitals. Interfrontal area with only a few scattered setae. Genae covered with short setae. Oral vibrissae weak (fig. 153a). Only two incomplete rows of acrostichals. Cell M joined with 2nd M_2 (fig. 153b). ***Pelomyia steyskali*** n.sp.
- 2(1). Genae narrow, one-half of width of third antennal segment, about one-sixth to one-eighth the eye height (fig. 151a). Lower occiput setose and postocular setae situated near eye margin. Eyes densely pubescent. Not densely gray-white pollinose species. Head and body bristles and setae black. ***Dasyrhicnoessa*** Hendel. 3
- Genae broad, much wider than third antennal segment, almost equal to height of eye (fig. 154a). Lower occiput bare and postocular setae well spaced from eye margin. Eyes bare, body silvery-gray pollinose. Head bristles yellow, thorax with bristles mostly yellow and setae all yellow. ***Tethina variseta*** (Melandrer).
- 3(2). Thorax, abdomen, and occiput mostly black, gray pollinose. Male genitalia as in figure 151f. The lower lobe of surstylus rounded at apex and setose on inner margin. Body 2.3–2.5 mm. ***insularis*** Aldrich.
- Entirely rufous species except for brown to black markings on abdomen. Male genitalia as in figure 152c. The lower lobe of surstylus truncate at apex and entirely bare. Body 1.5 mm. ***vockerothi*** n.sp.

Genus **DASYRHICNOESSA** Hendel

Dasyrhicnoessa Hendel, 1934, Tijdschr. Ent. 77:38. Type-species, *Rhicnoessa fulva* (Hendel), by original designation.

Differentiated from *Tethina* by lacking the polished tubercle on each side of face, lacking a median carina or tubercle on lower portion of face; eyes densely pubescent; the postocular setae extending near eye margin and lower occiput and posterior portion of each gena with numerous setae (fig. 151a); acrostichal setae in six rows; and surstylus bilobed, having a prominent, articulated, basal lobe (fig. 151f). The aedeagus is slender and bare. According to Vockeroth

(pers. comm.), the posterior spiracles of the puparia are borne on prominent tubercles. Two Hawaiian species fit in this genus.

***Dasyrhicnoessa insularis* (Aldrich), new combination** (figs. 151a-f)

Tethina insularis Aldrich, 1931, Proc. Haw. Ent. Soc. 7(3):395. Type-locality: Wake Island.

Oahu, Maui, Hawaii, French Frigate Shoal, Pearl and Hermes Reef, and Palmyra Island (probably on all of the islands). Also Canton Island.

Immigrant. Probably widespread over Micronesia and possibly other areas of the Pacific. First recorded from Hawaii (Pearl and Hermes Reef), in the original description, collected April-June, 1923.

Biology: Unknown. Abundant along the seashores. Probably breeds in seaweed and rotting vegetation.

According to Dr. J. R. Vockeroth (pers. comm.), this species should be referred to *Dasyrhicnoessa*. It appears to fit the concept of this genus except that Hendel's original description of the type species indicated only four rows of acrostichal setae. He did, however, include species with six rows (*sexseriata* Hendel) in his concept so the number of rows of acrostichal setae is obviously not a generic character.

This fits in the complex of species which have all-black bristles and setae on the head and thorax, and which have the thorax and abdomen predominantly black or dark brown in ground color. It is differentiated by having six to eight rows of acrostichal setae; comparatively narrow genae, about one-sixth as wide as eye height; also, by male genital characters (fig. 151f).

Head as in figure 151a, yellow except for upper two-thirds of occiput which is black, covered with gray pollen. Vertex and upper median portion of front golden-brown. Three pairs of strong fronto-orbital bristles, equal in size to ocellars, also three pairs of moderately strong interfrontals, the lower two pairs are cruciate. Postocellars prominent, converging. Eyes almost round. Antennae yellow, tinged with brown on third segment. Arista pubescent. Clypeus, palpi, and mouthparts yellow; in some specimens the clypeus is tinged with brown. Thorax mostly black in ground color, densely gray pollinose. Margin of scutellum, humeri, and halteres yellow. Mesonotum with four strong pairs of dorsocentral bristles and one strong pair of prescutellars. Scutellum bare except for the four marginal bristles. Legs yellow, except for black apical tarsomeres; densely black setose. Wings subhyaline, venation similar to other members of this genus except that crossvein r-m is distinctly before middle of 1st M_2 (fig. 151e). Abdomen subshining dark brown to black in ground color with faint gray pollinosity and with apices of terga narrowly yellow. Male genitalia as in figure 151f; the ventral arm of the surstylus is comparatively slender, rounded at apex and both lobes of the surstylus are densely setose especially on inner margins. Sixth and seventh terga apparently combined and project ventrally as a prominent lobe; also a sharp pointed lobe extends ventrally from each side of eighth tergum (fig. 151f). The females have long

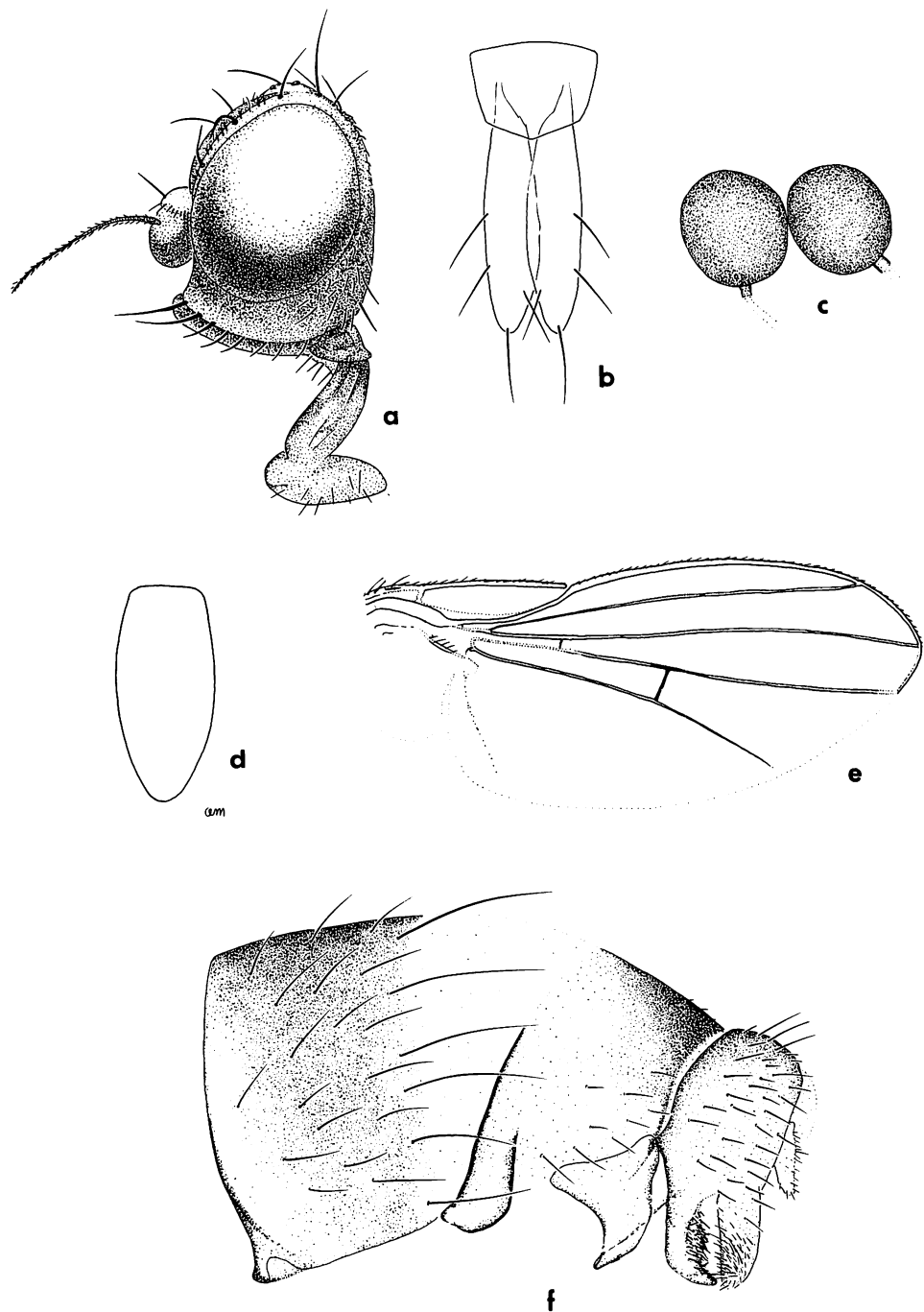


Figure 151—*Dasyrhicnoessa insularis* (Aldrich): a, head; b, cerci of female; c, spermathecae; d, atrial sclerotization of female; e, wing; f, male genitalia.

slender cerci, each with prominent bristle-like setae (fig. 151b). Two spermathecae present; these are black, round with short necks (fig. 151c). The atrial scleritization (wall of genital chamber) is very narrow, forming a complete loop (fig. 151d).

Length: body, 2.7–3 mm.; wings, 2.5–2.7 mm. In the original, Aldrich gave the length for body as 2.2 mm.

***Dasyrhicnoessa vockerothi* Hardy and Delfinado, new species (figs. 152a–c)**

This species cannot be placed in the literature. In Melander's key (1952:202), it runs to couplet 15 but differs immediately from the two species included by having six rows of acrostichal setae and by its small size and almost entirely yellow to rufous body. It differs from *insularis* by the small size, predominantly pale coloring, and by the striking differences in male genitalia (fig. 152c).

First recorded by Hardy (1952a:463) as *Tethina* sp.?, taken on beach at Waimanalo, Oahu, September, 1951.

MALE. Entirely yellow, tinged with rufous, except for the reddish-brown compound eyes and a streak of brown to black across bases of terga three to five. **Head:** Shape very similar to that of *insularis* with genae narrow, the width equal to less than one-sixth of eye height. Three pairs of fronto-orbital bristles, the upper and lower pairs reclinate and slightly directed upward, the middle pair strongly bent outward extending over compound eyes, compound eyes almost round. Postocular setae situated very close to hind margin of eye.

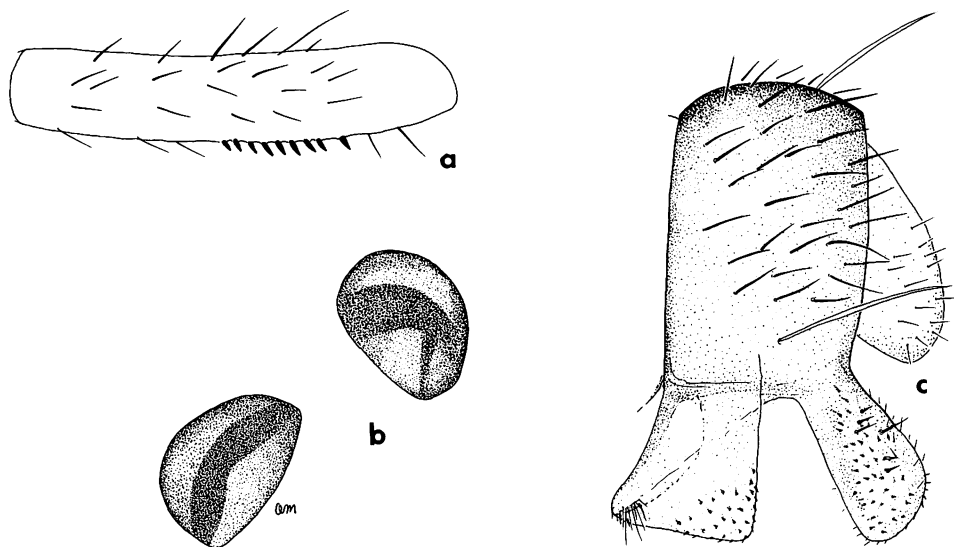


Figure 152—*Dasyrhicnoessa vockerothi* Hardy and Delfinado, n. sp.: a, front femur of male; b, spermathecae; c, male genitalia.

Lower portion of occiput rather thickly covered with short yellow setae. Other head setae and bristles dark brown to black. Front narrowed ventrally, at widest point opposite second pair of orbital bristles, about equal in width to one eye. Third antennal segment with a slight tinge of brown around upper margin. Mouthparts entirely yellow. Arista short, pubescent, about two times longer than third antennal segment. *Thorax*: Entirely yellow to rufous in ground color, covered with gray pollen. Dorsum of thorax with setae and bristles dark brown to black. Bristles and setae of pleura mostly yellow, tinged faintly with brown. Scutellum entirely bare, except for the four strong marginal bristles. Four pairs of prominent dorsocentrals and one pair strong prescutellars. Halteres pale yellow. *Legs*: Entirely yellow, covered with mixed brown and yellow setae on femora, yellow setae on tibiae and tarsi. Anteroven-tral surface of front femur with a short row of nine to ten thick, blunt spines extending from about middle to apical one-fifth (fig. 152a). *Wings*: Hyaline, veins yellow, tinged faintly with brown and venation very similar to that of *insularis* with r-m crossvein situated near basal one-third to two-fifths of cell 1st M_2 . *Abdomen*: First two terga and broad apices of three to five yellow, also terminal segments yellow to rufous. Male genitalia as in figure 152c, with the upper lobe of surstylus rather clavate, blunt at apex and densely short setose; lower lobe bare, rather leaf-like, truncate at apex. Aedeagus slender, bare.

Length: body, 2.0 mm.; wings, 1.75 mm.

FEMALE. Fitting description of the male except for sexual characters. Also, the abdomen is usually all rufous, tinged with brown on baso-median portion. Cerci long and slender, similar to those of *insularis* but the spermathecae are flattened on one side and have no sclerotized necks (fig. 152b).

Biology: Breeding in algae and other vegetation along the seacoast. Specimens have been reared from seaweed.

Holotype male and allotype female, Haena, Kauai, collected on beach, August, 1953 (D. E. Hardy). Approximately 200 paratypes, both sexes, from the following localities on five of the following main islands. Kauai: same as type. Oahu: Honolulu, August-October, 1966, on seaweed (J. R. Vockeroth); Hauula, July, 1955 (D. E. Hardy); Aiea, March, 1953 (D. E. Hardy); Kailua beach, March 26, 1968 (J. A. Tenorio); Waimanalo, May-October, 1951-1966 (D. E. Hardy, M. Adachi, J. R. Vockeroth); Ualapuu, December 27, 1944 (Y. Tanada); Waikiki, May, 1950 (M. Adachi); John Rogers Airfield, light trap, May, 1958 (E. J. Ford, Jr.). Maui: Hana, June, 1953, and July, 1958, collected on bagasse and seaweed on the beach (D. E. Hardy, C. R. Joyce, and L. W. Quate); Waihee beach, March, 1952 (M. Tamashiro); one specimen labeled Hanaula, 4000 ft., July 9, 1968 (J. A. Tenorio). Molokai: Waialua beach, July, 1952 (M. Tamashiro). Hawaii: Keaukaha dist. by old Puumaile Hosp., December 28, 1969, collected along seashore (J. A. Tenorio); Kailua, Kona, October 2, 1966 (W. Voss); Hilo, March 23, 1967 (J. R. Vockeroth); one specimen labeled Kahuku Ranch, 3000 ft., July, 1953 (D. E. Hardy).

Type, allotype, and a series of paratypes at B. P. Bishop Museum.

Paratypes deposited in the collections of the U.S. National Museum, British Museum (Natural History), Canada Department of Agriculture, and University of Hawaii.

This species is named after Dr. J. R. Vockeroth, Canada Department of Agriculture, Entomology Research Institute, Ottawa, who has studied the Hawaiian Tethinidae and provided the background information needed to bring this group up to date.

Genus **PELOMYIA** Williston

Pelomyia Williston, 1893, North Amer. Fauna 7:258. Type-species, *occidentalis* Williston, by monotypy, = *coronata* (Loew).

In addition to the characters given in the key to Hawaiian Tethinidae, the members of this genus are characterized by having short scattered setae over the genae (fig. 153a); a narrow gray rim along each side of oral margin continuous up median portion of face to bases of antennae; posterior ocelli situated near edge of occiput; front coxae elongate, about two-thirds as long as femora; hind tibiae lacking apical spines; and last section of vein $M_3 + 4$ just slightly longer than m crossvein (fig. 153b).

***Pelomyia steyskali* Hardy and Delfinado, new species (figs. 153a-f)**

This species has previously been treated under the concept of *coronata* (Loew) and is the same as was illustrated by Melander (1952:212, fig. 4 and also possibly fig. 3). His concept apparently included three distinct species. Under *coronata* in Stone et al. (1965:726), Dr. Vockeroth stated, "This species, as usually identified, is an unworked complex." The members of the *coronata* complex are differentiated by having the fronto-orbital bristles located slightly above middle of front, halfway between inner vertical bristles and antennae (fig. 153a); front orange, contrasting in color from dark brown to black ocellar triangle; antennae and legs predominantly with a faint translucent sheen and with faint indications of three brown vittae; wing venation as in figure 153b.

Mr. George Steyskal (USDA) has clarified the concept of *P. coronata* (pers. comm.) and has concluded that the species represented by Melander's figure 1 (*loc. cit.*) is the true *coronata*. The type of *coronata* is a female from "Georgia." Steyskal examined specimens from Florida, Missouri, and from the Mojave Desert, California (apparently one of the specimens was used by Melander for his figure 1). He also says that he believes Hendel's *P. cruciata* is a synonym of the species he considers *coronata*; "at least our specimen from Atherton, Missouri, from which series Hendel's type came, is the same."

Typical *coronata* is characterized by having the ninth tergum of the male extended into prominent pointed lobes (fig. 153g); this is readily seen *in situ*. *P. steyskali* is differentiated by having the apices of the ninth tergum deeply divided into two slender hairy lobes (fig. 153c). This is the species illustrated as *coronata* by Hennig (1939b:82, fig. 6). In other respects it seems to fit the concept

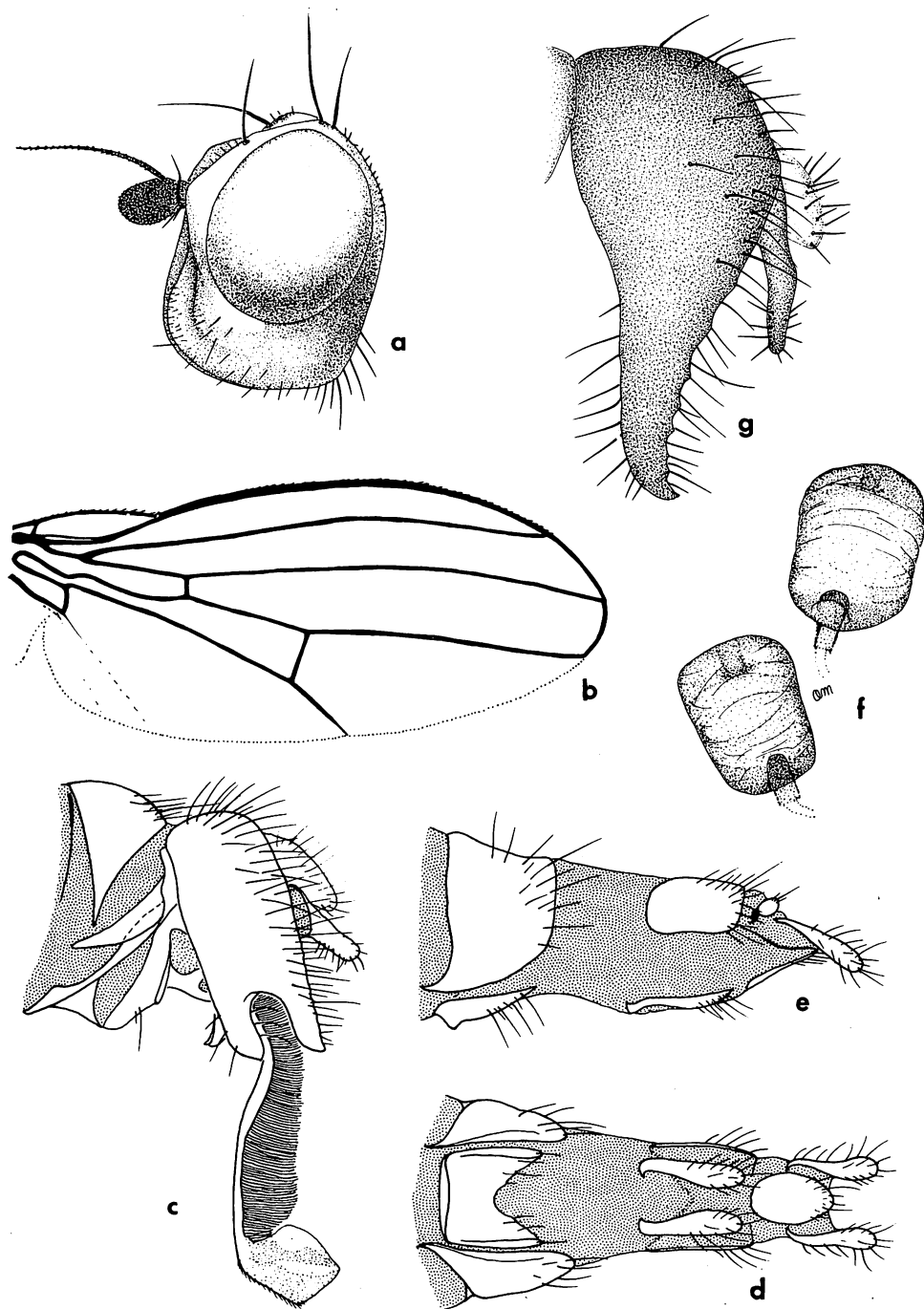


Figure 153—*Pelomyia steyskali* Hardy and Delfinado, n. sp.: a, head, lateral; b, wing; c, male genitalia, lateral; d, post abdomen of female, ventral; e, post abdomen of female, lateral (c-e drawn by George Steyskal); f, spermathecae. *P. coronata* (Loew): g, male genitalia, lateral.

of *coronata*. The head is shaped as in figure 153a, and the wing venation as in figure 153b. A pair of strong, rather slender, short, setose lobes (surstyli) are articulated with the dorsobasal portion of the epandrium. The aedeagus is long, stout, and densely hairy, ending in a setose, membranous, bulbous tip. Aedeagal apodeme elongate, rod-like.

Length: body and wings, 2.5–3.2 mm.

FEMALE. Fitting description of male except for sexual characters and fitting description of *coronata*. The cerci are long and slender (figs. 153d,e). Two spermathecae present; these are longer than wide (fig. 153f).

It is a pleasure to name this species after George Steyskal who has given us so much help and has contributed a great deal to this volume on the acalyptrates.

Holotype male and allotype female, 8 mi. N. Gold Beach, Curry Co., Oregon, June 29, 1972 (G. Steyskal). 78 paratypes, sexes approximately equal, from the following localities. Oahu, Hawaii, September 9–10, 1955 (M. R. Wheeler); Pukoo, Molokai, January 1, 1954 (S. Shimabukuro). Texas: Rio Hondo, January 30, 1950 (M. R. Wheeler). California: Thermal, August 14, 1955 (W. R. Richards); Thousand Palms, March 8–25, 1955 (W. R. M. Mason and W. R. Richards); San Francisco, August, 1915 (A. L. Melander); Berkeley, August, 1915 (A. L. Melander); Big Sur, September, 1945 (A. L. Melander); Arvin, March, 1935 (A. L. Melander); San Jose, September, 1949 (L. W. Quate); Tracy, San Joaquin Co., May, 1949 (R. F. Smith); Temblor Range, S.L.O. Co., April, 1964 (J. Powell); Livermore, Alameda Co., May, 1955 (M. Wasbauer); McClure's Beach, Marin Co., July 1961 (C. A. Toschi); Nr. Buttonwillow, Kern Co., June, 1951 (C. W. O'Brien); La Panza, S.L.P. Co., April, 1964 (J. Powell); Antioch, C. Costa Co., May, 1949 (J. W. McSwan). Washington: Kennewick, May, 1921 (A. L. Melander); Mukilteo, May, 1924 (A. L. Melander); Lanaka Bay, July, 1924 (A. L. Melander); Ilwaco, July, 1917 (A. L. Melander); Blynn, July, 1917 (A. L. Melander).

Also on hand are two specimens, one male, one female which may belong to this species although the dorsal lobe of the male surstylus is much broader, more rounded than others which have been observed from Lethbridge, Alberta, Canada, July 7, 1956 (O. Pech).

Type, allotype, and a series of paratypes returned to the U.S. National Museum. Other paratypes in the collections of the Canada Department of Agriculture, Ottawa; University of California, Berkeley; B. P. Bishop Museum, and the University of Hawaii collection.

Genus **TETHINA** Haliday

Opomyza, subg. *Tethina* Haliday, 1838, Ann. Nat. Hist. (1839) 2:188. Type-species, *illota* Haliday, by monotypy.

Rhinoessa Loew, 1862, Wien. Ent. Mschr. 6:174. Type-species, *cinerea* Loew, by monotypy, = *grisea* (Fallén).

Seashore-inhabiting species characterized from *Dasyrhinoessa* Hendel by the

following characteristics (based upon information presented by Dr. J. R. Vockeroth, pers. comm.): having a shining callosity on each side of face above vibrissa; with a median tubercle projecting above oral margin; eyes bare; postocular setae rather widely spaced from eye margin and with a very broad bare area over hind portion of gena and lower portion of occiput (fig. 154a); acrostichal hairs in four irregular rows counted opposite anterior dorsocentral bristles; and surstylus of male simple, not with a basal lobe (fig. 154b).

Tethina variseta (Melander) (figs. 154a-f)

Rhinoessa variseta Melander, 1952, J.N.Y. ent. Soc. 59:209. Type-locality: Long Beach, California.

Oahu, Kauai, Maui, Kahoolawe, Hawaii, French Frigate Shoal, and probably all of the Hawaiian Islands. This has been known in the Hawaiian literature as *T. albula* (Loew) and was first recorded by Wirth (1947) collected at Waianae, Oahu, January, 1946. The earliest record found in collections is Barbers Point, Oahu, June, 1919.

Immigrant. California.

Biology: Unknown. Probably breeds in rotting vegetation along beaches.

The Hawaiian specimens which have previously been recorded as *albula* run to *variseta* in Melander's key (1952:201). They fit his original description (p. 209) and also compare favorably with specimens from California. It is differentiated from other *Tethina*, which have the genae very broad and equal to more than half the height of the compound eyes, by having at least the apical scutellar bristles black and usually all, or most, of the dorsocentral bristles black; also the coxae and femora mostly black in ground color and the male genitalia as in figure 154b. The Hawaiian specimens typically have all of the dorsocentral, scutellars, outer postalars, supraalars, and presutural bristles black, the other bristles and setae of thorax yellow; the notopleurals and humerals are sometimes tinged faintly with brown. Specimens on hand range all the way from this condition to those which have all of the thoracic bristles yellow, with the exception of the apical scutellars.

Head shaped as in figure 154a, with all of the bristles and setae yellow and mostly gray pollinose, dull rufous through median portion of front. Antennae yellow, sometimes apex and outer surface of third segment tinged with brown. Arista black, very short, about two times longer than third segment and microscopically pubescent. The polished tubercle on each side of face clear yellow, lower median portion of face with a raised carina. Thorax black in ground color, densely gray pollinose except for brown pollinose apical portion of scutellum. Halteres yellow. Legs with coxae and femora predominantly black, gray pollinose; tibiae and tarsi yellow. We see nothing distinctive about the wing venation, the r-m crossvein is situated at middle of cell 1st M_2 and the last section of vein $M_3 + 4$ is equal to the penultimate section of vein $M_1 + 2$. Abdomen black in ground color except for narrow yellow apices of terga, densely gray pollinose and yellow setose. Male genitalia as in figures 154b, d,

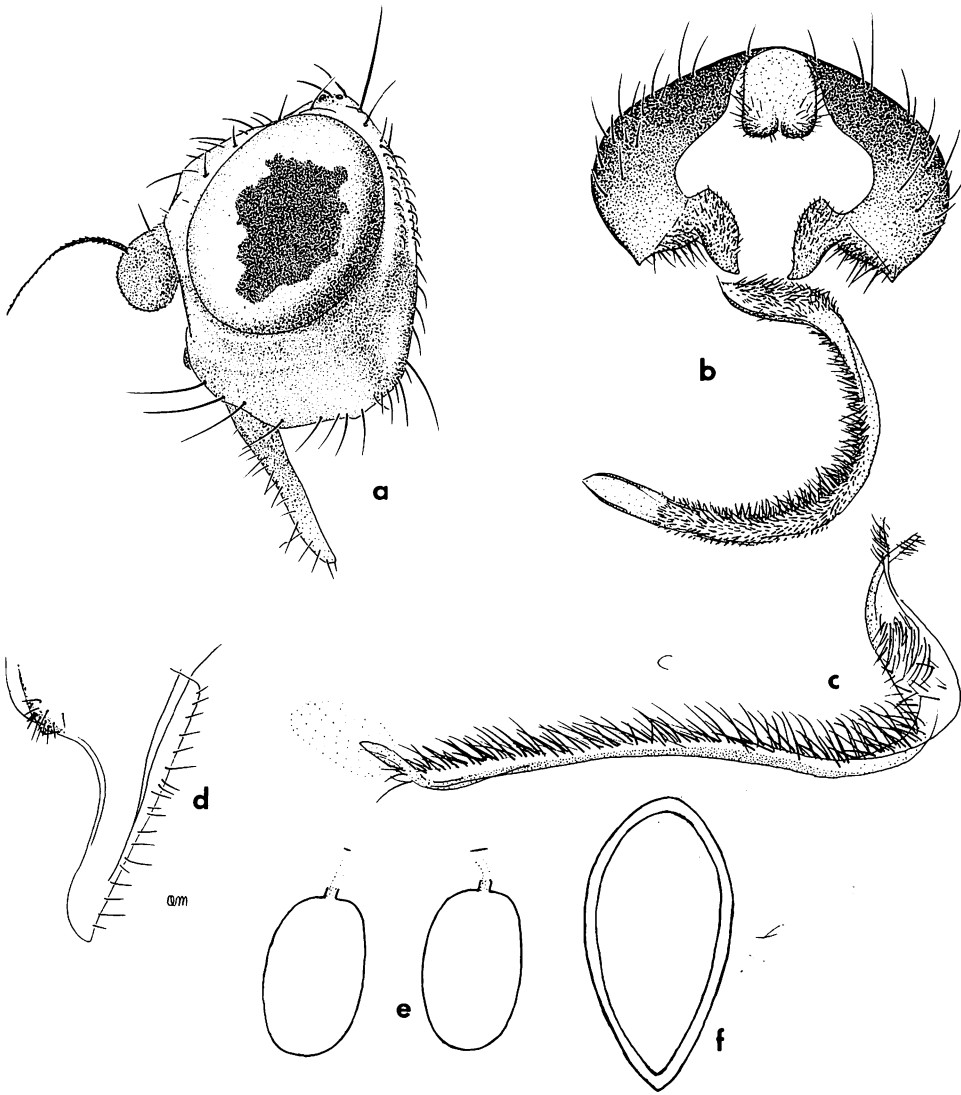


Figure 154—*Tethina variseta* (Melander): a, head, lateral; b, male genitalia, end view, hypandrium and base of aedeagus not shown; c, aedeagus; d, surstylus, lateral; e, spermathecae; f, atrial sclerotization of female.

with the surstyli broad at bases, extended into a narrow lobe at each upper apical margin. As seen from ventral view the inner surface of each surstylus is covered with short setae. Aedeagus with inner margin very densely fringed with hair (fig. 154c). Atrial sclerotization of female as in figure 154f and spermathecae as in figure 154e.

Length: body, 3.0–3.8 mm.; wings, 2.5–3.0 mm.

Family CANACEIDAE
The "Beach Flies"

Rather small, dark-colored flies whose habits and appearance are similar to those of Ephydriidae. These families are not related, however, and the canaceids are readily differentiated by having the cubital cell and cell M (2nd basal) developed; subcostal vein complete; only one break in the costa; postvertical bristles absent; seven visible segments in abdomen; third antennal segment small and round, arista short pubescent; and in Hawaiian species with prominent spinules along costa. The genitalia of both sexes are distinctive and they also differ in other details.

In addition to the above features, these flies have the oral opening and the clypeus large and conspicuous; front broad in both sexes, with three to five pairs of divergent fronto-orbital bristles; ocellar, vertical, and genal bristles strong; genae broad, with two to four pairs of bristles in Hawaiian species; upper face swollen; antennae rather widely separated at bases; four pairs dorsocentral bristles, one pair presutural; wings as in figures 155f and 158d; and male and female genitalia as in figures 161c-e and 163a-e; cerci of female spinose in Hawaiian species.

This is a small family of approximately 40 known species for the world. They breed typically along the coasts between the tide levels on algae-covered rocks. In Hawaii a most interesting complex of species of *Procanace* have evolved in freshwater habitats. The only other known record of possible freshwater breeders is *P. opaca* de Meijere, from Java. Some other species have been collected in estuaries and are obviously brackish water breeders. The invasion of freshwater habitats was a very important evolutionary event and considerable adaptive radiation has occurred in the three known groups of Hawaiian Diptera which have accomplished this: *Telmatogeton* in Chironomidae; *Neoscatella* in Ephydriidae; and *Procanace* in Canaceidae.

Apparently the only previous biological notes on this family are by Williams (1938:108-110) and Gercke (1887). Williams says the larvae are saprophytic or perhaps feed on living algae. For further biological data refer to the discussion under *Procanace*.

For revisional studies refer to Wirth (1951, 1969).

Four species in two genera have been previously recorded from Hawaii; two are apparently endemic and two introduced. Six additional native species plus one unnamed species are being described here.

KEY TO GENERA AND SPECIES OF HAWAIIAN CANACEIDAE

1. One pair of strong bristles present on front just below and laterad to ocellar triangle, mesofrons bare, lacking setae; four pairs of strong genal bristles; scutellum with two to four strong setae on disc. **Canaceoides** Cresson. 2

- No mesofrontal bristles with at least a few setae on lower median portion of front; three pairs of genal bristles; scutellum lacking setae on disc. **Procanace** Hendel. 3
- 2(1). Front femur of male with bristles scattered in irregular rows over posterior surface. Inner lobe of male surstylus broad, truncate distally, covered with numerous short spines (fig. 155g). Eighth tergum of female with a broadly V-shaped indentation in middle of hind margin. Widespread on coasts of all Hawaiian Islands, lower California, Mexico, Peru, Galapagos Islands. **angulatus** Wirth.
- Front femur with two rows of bristles confined to upper half of posterior surface and with no bristles along posteroventral line. Inner lobe of surstylus attenuated, bearing three to four strong, black, preapical spines and three to four smaller spines (fig. 157e). Eighth tergum of female straight on hind margin. Coasts of all Hawaiian Islands. **hawaiiensis** Wirth.
- 3(1). Predominantly dull black, including squamae and halteres, often with brownish pollinosity over mesonotum and scutellum and a greenish sheen over front and face. Clypeus very large, nearly as long as face (figs. 163f,g). Mesofrons with only a few setae on lower portion. Acrostichal setae lacking. Wings dark, smoky gray. Usually two strong genal bristles. Nigroviridis complex of species. 4
- Mostly light-gray pollinose, with squamae and halteres yellow. Clypeus rather small, less than half as long as face (figs. 165e,f). Front with numerous setae over lower half to two-thirds. Acrostichals well developed. Wings subhyaline. Three strong genal bristles. Oahu, Japan. **williamsi** Wirth.
- 4(3). Males. 5
Females. 11
- 5(4). Surstylus bifurcate, the two lobes almost equal in size (fig. 160d), lacking a small basal lobe on outer margin. 6
- Surstylus not divided except for a small basal lobe arising from outer ventral margin (fig. 163c). 7
- 6(5). Outer lobe of surstylus straight, broad, not tapered,

- and blunt, rounded at apex (fig. 160d). Oahu and Kauai. **bifurcata** n.sp.
 Outer lobe curved upward, tapered at apex, with apical portion thinner, more translucent than remainder of lobe (fig. 161c). Hawaii, Maui, and probably Molokai. **confusa** n.sp.
- 7(5). Surstylus slender, boomerang-shaped (fig. 166d). Oahu, Kauai. **wirthi** n.sp.
 Surstylus not as above. 8
- 8(7). Surstylus two to three times longer than wide, tapered distally (figs. 158e, 162e, 163c). Front dull, opaque black, lacking a green sheen; mesonotum and scutellum dark gray pollinose. 9
 Surstylus subrectangular, about one-half longer than wide, scarcely tapered, broadly rounded distally (fig. 163c). Front, and often face, with a distinct greenish sheen; mesonotum and scutellum chocolate-brown pollinose with a faint greenish sheen. Kauai. **nigroviridis** Cresson.
- 9(8). Front, and usually face, with a coppery green sheen, as seen in strong light; mesonotum and scutellum chocolate-brown pollinose and with a faint green sheen. Surstyli short and broad about one-half longer than wide, scarcely tapered (fig. 162e). 10
 Front dull black, face gray, mesonotum and scutellum black, with dark gray pollinosity and lacking a green sheen. Surstyli comparatively slender, approximately three to four times longer than wide, tapered distally (fig. 158e). Hawaii, Maui, Molokai. **acuminata** n.sp.
- 10(9). Surstylus slightly tapered at apex as seen in end view (fig. 163c). Hypandrium forming a complete ring beneath apices of surstyli. Kauai. **nigroviridis** Cresson.
 Surstylus broadly rounded at apex as seen in end view (fig. 162e). Hypandrium very differently formed, developed into two upcurved arms on venter. Molokai, Maui, and Hawaii. **constricta** n.sp.
- 11(4). Second tergum approximately equal in length to other terga, or only slightly longer than one or three, in *wirthi* n.sp., and not greatly elongated. 12

- Second tergum greatly elongated so that one plus two are as long or longer than remainder of abdomen (fig. 158a). Hawaii, Maui, Molokai.
 **acuminata** n.sp.
- 12(11). Abdomen constricted medianly (fig. 162a). Eighth tergum narrow, about four and one-half times wider than long; cerci short and broad (fig. 162b). Ninth sternum very large, complete and angulate posteriorly (fig. 162c). 17
 Not as above. Eighth tergum longer than wide. Ninth sternum varied. 13
- 13(12). Spermathecae without necks (fig. 166b), atrial sclerotization (wall of genital opening) forming a round ring (fig. 164c). 14
 Spermathecae with short necks (fig. 161b). Posterior plates of eighth sternum each with seven to eight long spines and eighth tergum with a row of long and short setae (fig. 161d). Atrial sclerotization elliptical in outline (fig. 160e). 16
- 14(13). Eighth tergum with numerous setae of varying lengths (figs. 161c, 163d). Spermathecae with a short sclerotized section at end of each filamentous duct before opening into main duct (fig. 163b). 15
 Eighth tergum comparatively narrow, with four long setae (bristles) on hind margin (fig. 164a). Filamentous ducts not sclerotized at ends (fig. 164b). Kauai. **quadrisetosa** n.sp.
- 15(14). Cerci short, broad, as wide as long. Eighth tergum cordate, as long as wide. Ninth sternum nearly divided in middle of anterior margin. Seventh sternum large, at least two times longer than atrial sclerotization (sclerotized wall of genital cavity) and convex posteriorly (fig. 166e). Oahu and Kauai. **wirthi** n.sp.
 Cerci longer than wide. Eighth tergum about two times wider than long (fig. 163d). Ninth sternum entire, not concave on anterior margin. Seventh sternum scarcely longer than atrial sclerotization and concave on posterior margin (fig. 163e).
 **nigroviridis** Cresson.
- 16(13). Oahu and Kauai. **bifurcata** n.sp.
 Maui, Hawaii, and probably Molokai. . . . **confusa** n.sp.

- 17(12). Tergum 3 completely divided medianly. Hawaii. . .
 n.sp.
 Tergum 3 not divided. Molokai, Hawaii, Maui. . .
 **constricta** n.sp.

Genus **CANACEOIDES** Cresson

Canaceoides Cresson, 1934, Trans. Amer. ent. Soc. 60:221. Type-species,
Canace nudata Cresson, by original designation.

Procanace Curran, 1934, Proc. Calif. Acad. Sci. 21:160. Type-species, *panamen-*
sis Curran, by original designation, preocc. by *Procanace* Hendel, 1913.

Neocanace Curran, 1934, Fam. Gen. N. Am. Dipt.:357 (**new name** for *Pro-*
canace Curran). Type-species, *Procanace panamensis* Curran, automatic.

Members of this genus are characterized by having a pair of strong inter-frontal bristles just below and outside the ocellar triangle; front bare, lacking setae; postocellar bristles weak or absent; four genal bristles; anterior notopleural bristle poorly developed; and disc of scutellum with 2-4 strong setae; also, male surstyli bilobed (fig. 157a). These are small brownish black, gray pollinose species with the face, genae, and clypeus silvery-gray; the wings faintly tinged with brown and the venation as in figure 155f. The two Hawaiian species are alike in most details and can be separated only by the genitalia.

Two species are known from Hawaii. These were confused as one in earlier literature under the name *nudata*. First recorded as *Canace nudata* Cresson by Bryan (1926b:279).

For a detailed diagnosis including key to known species refer to Wirth (1969).

Canaceoides angulatus Wirth (figs. 155a-g, 156a-d)

Canaceoides angulatus Wirth, 1969, Proc. Calif. Acad. Sci. 4th Ser., 36:556
 (male, female). Type-locality: Waimea, Oahu.

Canaceoides nudatus (Cresson), of authors, in part, misidentification.

Oahu, Kauai, Molokai, Maui, Hawaii, Laysan Island, Lisianski Island, Wake Island, Midway Island, Baja California, islands in the Gulf of California, Mexico, Peru, and Galapagos Islands.

Immigrant. This species is widely distributed along seashore on wet tidal rocks covered with algae, throughout the Hawaiian Islands, Baja California, Gulf of California, Mexico, Peru, and Galapagos Islands.

Differentiated from *hawaiiensis* Wirth by having the front femur of male with bristles scattered in irregular rows over entire posterior portion; the inner lobe of the male genital process (surstylus) broad, truncate distally and covered with numerous short spines (fig. 155g). Head as in figures 155a,b. Ninth sternum of female narrow, nearly two times wider than long, gently concave on

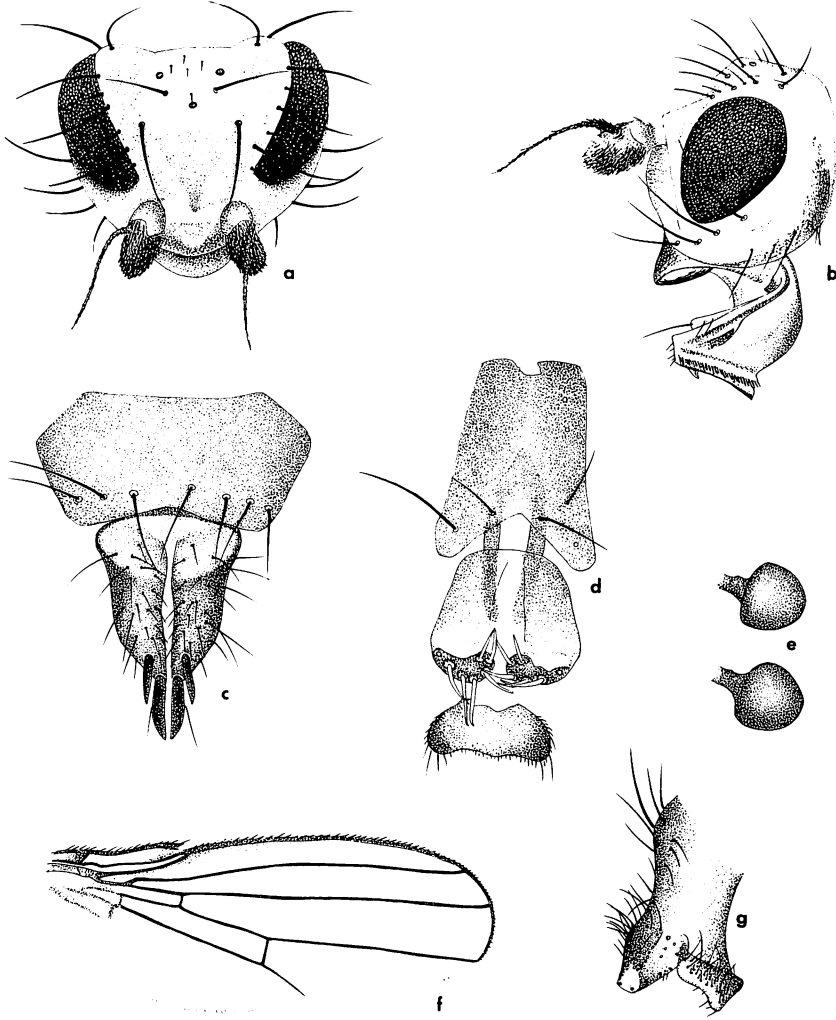


Figure 155—*Canaceoides angulatus* Wirth: a, head, front view; b, head, lateral; c, female post abdomen, dorsal; d, female post abdomen, ventral; e, spermathecae; f, wing; g, surstylus of male, lateral.

posterior margin (fig. 155d) and eighth tergum with a broadly V-shaped concavity on hind margin (fig. 155c). Spermathecae as in figure 155e.

For a detailed description refer to Wirth (*loc. cit.*). Wirth stated that “the anterior crossvein is located fairly near the middle of the discal cell (0.40–0.46 of its length), thus affording a tentative separation from the second Hawaiian species, *C. hawaiiensis*, new species, in which this ratio is 0.33–0.39.” We are unable to see any significant differences in these.

Length: body, 1.7–2.0 mm.; wings, 2.0–2.4 mm.

Larvae: Very similar to *hawaiiensis* but differs by having irregular rows of strong spines on dorsum of thorax and abdomen. These spines are confined to abdominal segments 5-8 and are much stronger on 8 in *hawaiiensis*. Length, 3.75-4.0 mm.; greatest width, 1.0-1.25 mm. Body slender fusiform, brownish, minutely spiculate ventrally and dorsally with irregular rows of strong spines in addition to small ones. Anterior spiracles prominent, stalked, with 8-10 branches (fig. 156b); posterior spiracular tubes on a small tubercle, somewhat separated. Cephalopharyngeal skeleton heavily pigmented (fig. 156a) except ventral cornua and dorsal bridge. Dorsal cornua very slender, curved; ventral cornua fairly broad with subapical protrusion, without windows. Dorsal bridge narrow. Mouthhooks (fig. 156d) large, tri-dentate with sharp anterior teeth and small windows. Parastomal sclerite (bar) present. Other details are as in figures 156c,d. *Puparium*: Length, 2.25-3.0 mm., greatest width, 1.0-1.25 mm. Brown, broadly fusiform, spinose as in larva. Anterior spiracle prominent, with dark-brown stalk, 8-10 pale branches.

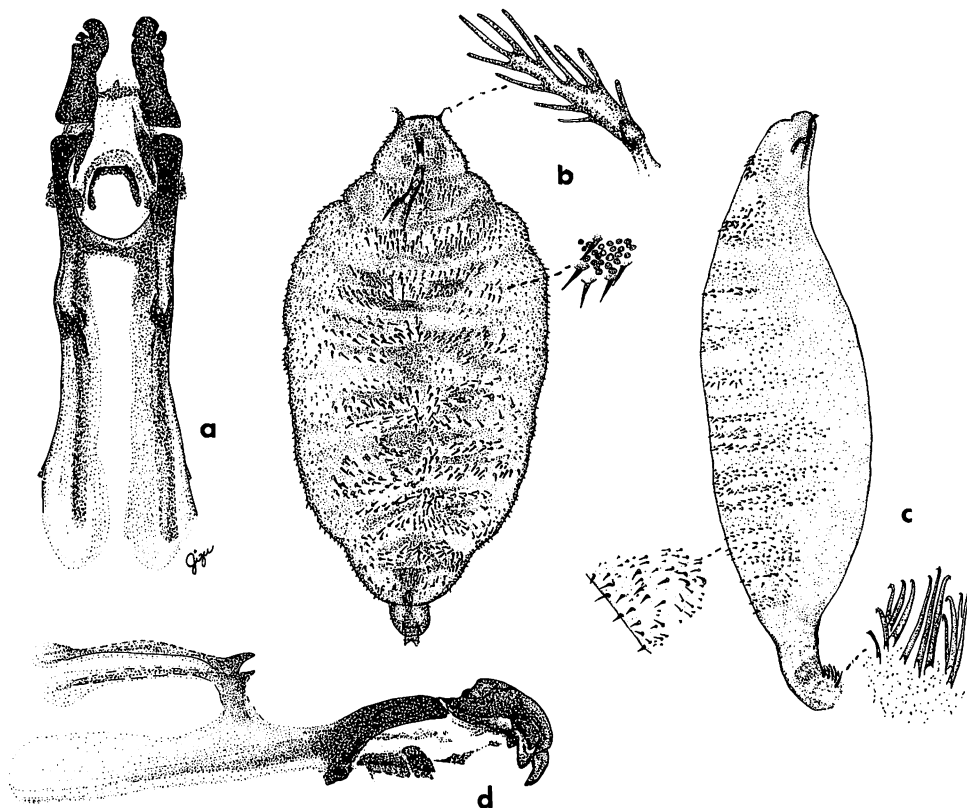


Figure 156—*Canaceoides angulatus* Wirth, immature stages: a, cephalopharyngeal skeleton, from puparium, ventral; b, puparium showing anterior spiracle and section of integument enlarged; c, third instar larva; d, cephalopharyngeal skeleton from larva, lateral.

Posterior spiracular tubes partly extruded, separated, on a small tubercle. Other details as in figures 156a,b.

Canaceoides hawaiiensis Wirth (figs. 157a-f)

Canaceoides hawaiiensis Wirth, 1969, Proc. Calif. Acad. Sci. 4th Ser., 36:561 (male, female). Type-locality: Hana, Maui.

Endemic. Widely distributed throughout the Hawaiian Islands, collected on tidal rocks along seashore: Maui, Hawaii, Oahu, Molokai, Kauai, and Nihoa Island.

Differentiated from *angulatus* Wirth by front femur having one row of bristles each on posterior and posterodorsal surfaces and no bristles on posteroventral surface; the inner lobe of the male surstylus attenuated and

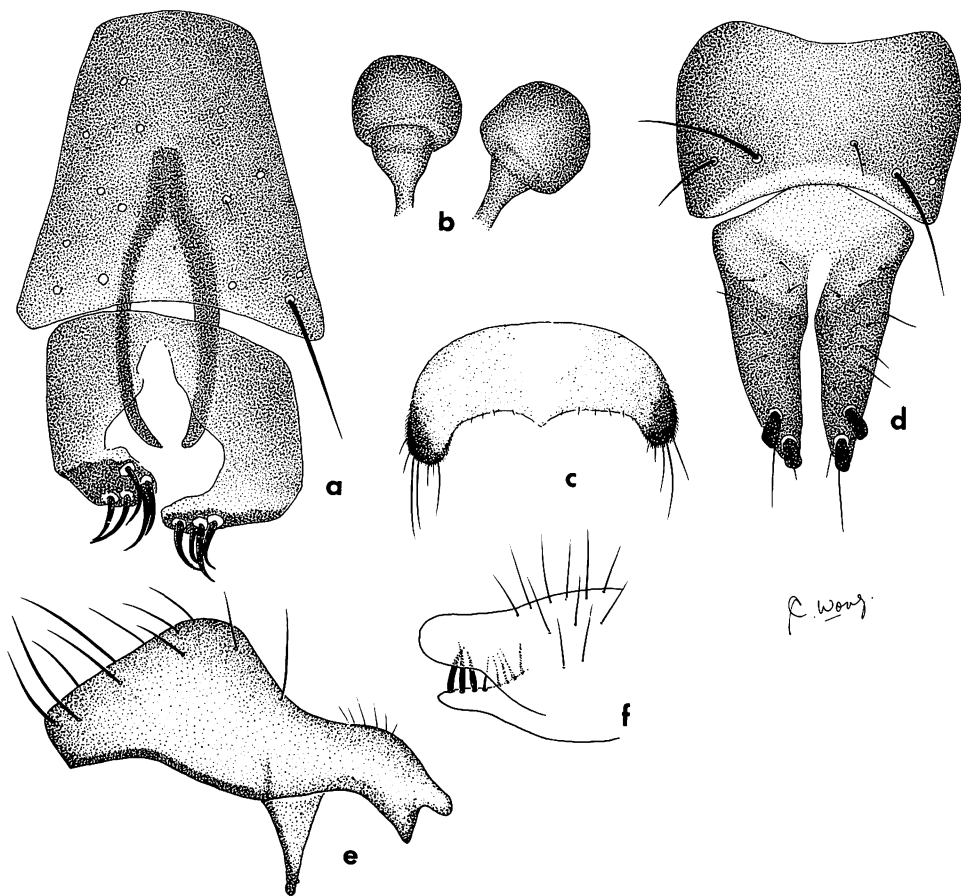


Figure 157—*Canaceoides hawaiiensis* Wirth: a, post abdomen of female, ventral; b, spermathecae; c, ninth sternum of female; d, post abdomen of female, dorsal; e, epandrium and surstylus of male, lateral; f, surstylus, outer surface.

bearing a preapical clump of 3-4 strong black spines and 3-4 smaller spines (figs. 157e,f). Also, by the ninth sternum of female distinctly bilobed on hind margin (fig. 157c) and eighth tergum straight, not indented on hind margin. Other characters of female as in figures 157a-d. Wirth has given more complete descriptive details in the original. He said, "it is also a slightly smaller species than *C. angulatus*, and the anterior crossvein is situated more proximad." We see no significant differences in the Hawaiian specimens.

Length: body, 1.7-2.0 mm.; wings, 1.65-2.2 mm.

Larvae: Cephalopharyngeal skeleton, taken from puparium, heavily pigmented except ventral cornua. Dorsal cornua very slender, tapered posteriorly; ventral cornua broad, straight, with small subapical protrusion. Dorsal bridge rather narrow. Mouthhooks robust, tri-dentate with sharp pointed anterior teeth. Based upon one specimen.

Puparia: Length, about 3.0 mm.; greatest width about 1.2 mm. Body broadly fusiform, light brown, entirely covered with minute spines with a few strong ones scattered on dorsum of posterior abdominal segments. Anterior spiracles prominent, hornlike. Posterior spiracular tubes somewhat separated and not protruded. Terminal segment with a small group of multiserial spines ventrally.

Genus **PROCANACE** Hendel

Procanace Hendel, 1913, Suppl. Ent. 2:93. Type-species, *griseszens* Hendel, by monotypy.

For key to species see Wirth (1951:253).

Characterized by lacking bristles on mesofrons but with at least a few setae on lower portion; anterior notopleural bristles strong; three pairs, rarely two genal bristles; disc of scutellum bare; and fourth tarsomere with flattened lanceolate distal spines on venter of front legs, in both sexes.

Two species have previously been recorded from Hawaii, one which breeds in the intertidal zone and one in fresh water streams. It is now apparent that a complex of species is present in Hawaii which breeds in the algae on rocks in rapidly flowing mountain streams. The following notes on biology and habits by Williams (1938:110) under *Procanace nigroviridis* Cresson would pertain to all species of this complex.

Rather intensive studies have been made on various streams throughout the Islands, and the adult populations appear to be highest during the summer months when the streams are at their lowest levels. At this time numerous empty puparia are found attached on exposed rocks which would be submerged when the water level is high. The larval and pupal stages are spent under water where the current is swift. It appears probable that these flies produce many generations per year.

A high percentage of the canaceid puparia are parasitized and it seems evident that the parasitism rate is very high in endemic Hawaiian Diptera. We find large numbers of small parasitic wasps (Eucoilinae, Cynipidae) in the

same habitat with *Procanace*, *Neoscatella* (Ephydriidae), and *Telmatogeton*, (Chironomidae), and, on several occasions, observed aquatic Hymenoptera crawling about on the rocks under water where the larvae and puparia of *Procanace* and *Neoscatella* were abundant. We have also collected a species of *Lispocephala* (Muscidae) which obviously preys upon Diptera and possibly other animals living in the swift water.

One species, *Procanace confusa* n.sp. was found using the empty puparia of *P. acuminata* n.sp. as a "shelter." Also many empty puparia of *acuminata* and *nigroviridis* were found harboring two species of *Neoscatella*, *warreni* (Cresson) and *clavipes* (Wirth). This curious relationship needs to be investigated.

***Procanace acuminata* Hardy and Delfinado, new species**

Fitting near *nigroviridis* Cresson but differing by having the front dull black and mesonotum and scutellum black, with dark gray pollinosity, lacking a coppery green sheen. Male surstyli comparatively slender, 3-4 times longer than wide, tapered distally (fig. 158e) and second tergum of female greatly elongated (fig. 158a).

MALE. Fitting the description of *nigroviridis* in most respects, except for the head and body coloration, lack of a greenish sheen, and the genital characters. Wing as in figure 158d. The surstyli are narrowly connected to the epan-drium, are typically slender, tapered to a rather sharp point distally, about four times longer than wide, with numerous hairs on upper inner margin but lacking conspicuous setae on outer margin. The secondary lobe is small, rounded, and has long hairs around the margin (fig. 158e). The lobes of the tenth sternum project conspicuously beyond the anterior margin of the epan-drium. Specimens from Molokai have the surstyli more broad, rather blunt distally and with three prominent setae on outer surfaces. These are not being designated as part of the type series.

Length: body, 3.5 mm.; wings, 3.7 mm.

FEMALE. Abdomen with first two terga very closely joined, appearing fused, greatly elongated, about equal in length to remaining segments combined. Cerci broad distally, each with three large spines, the outermost spine more dorsal in position (fig. 158b); also, with three prominent setae ventrally. Eighth tergum with a row of short posterior setae medianly and one prominent bristle on each side. Seventh sternum shield-like, longer than wide with one prominent bristle on each side of posterior margin. Eighth sternum with 8-9 short spines on each posterior plate. Ninth sternum with a V-shaped cleft in middle of anterior margin, rounded posteriorly, abundantly covered with short and long setae. Atrial sclerotization (wall of genital chamber) rounded in outline. Two rounded spermathecae, without necks, but each with a long filamentous duct leading to a sclerotized opening.

Length: body and wings, 4.0 mm.

Larvae: Length about 2.50 mm.; 0.75 mm. at its greatest width. Body fusiform, pale green, covered with dark spines, spinules, and pebbly ornamen-

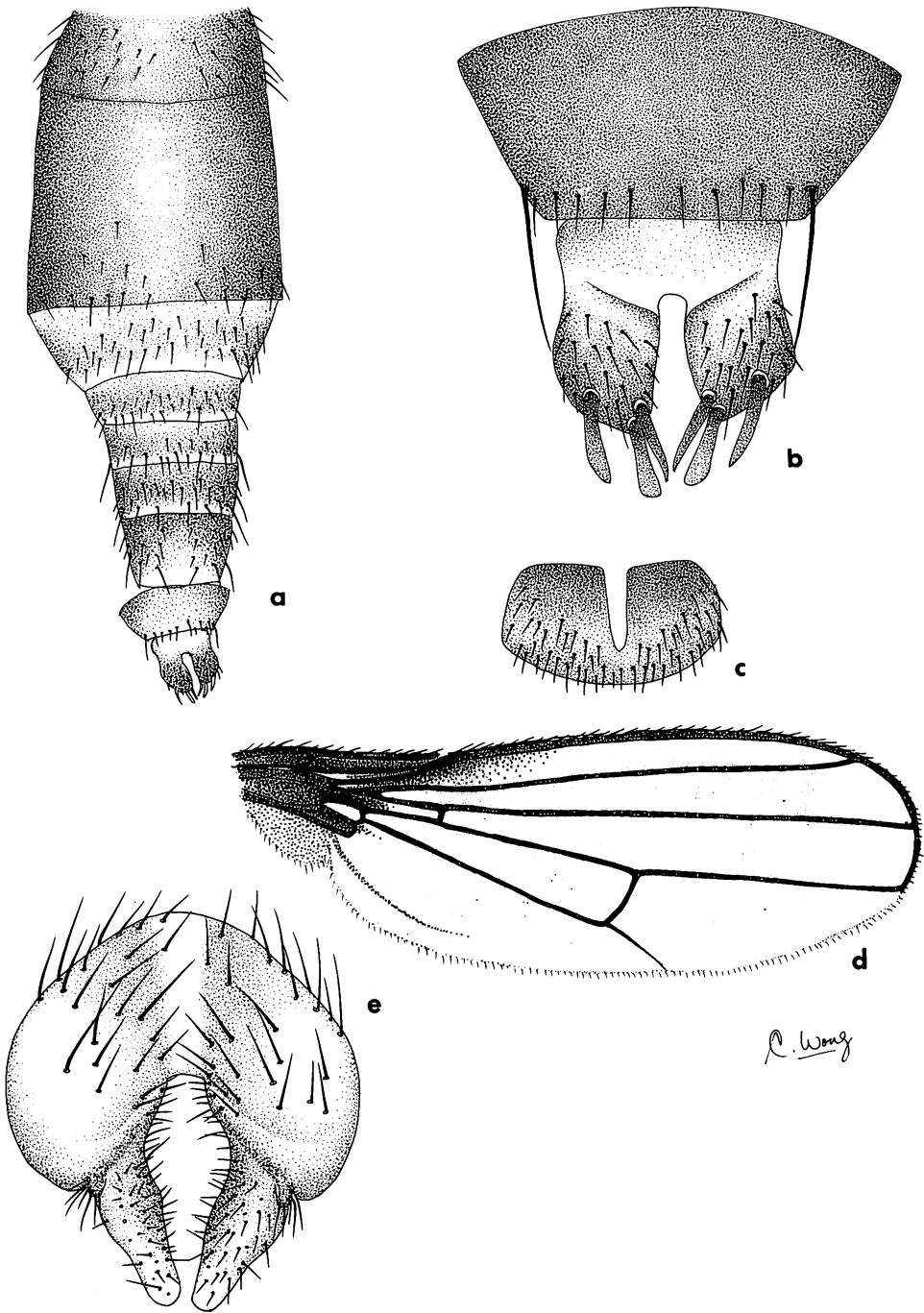


Figure 158—*Procanace acuminata* Hardy and Delfinado, n. sp.: a, abdomen of female, dorsal; b, post abdomen of female, dorsal; c, ninth sternum of female; d, wing; e, male genitalia, end view.

tation. Segments 1-7 lateroventrally each with a group of multi-serial, strong, curved spines; ventrally with 3-4 rows of transverse spines interrupted at middle. Terminal segment with a group of multiserial, strong, curved spines. Anterior spiracles fairly prominent, simple; posterior spiracular tubes exerted (fig. 159b). Cephalopharyngeal skeleton dark pigmented (fig. 159a); dorsal cornua very slender, curved, and pointed posteriorly; ventral cornua broad, straight, without windows. Dorsal bridge well developed; parastomal sclerite (bar) present. Mouthhooks curved, deeply dentate, with sharply pointed teeth and small subbasal tooth and small central windows. Third instar larva with

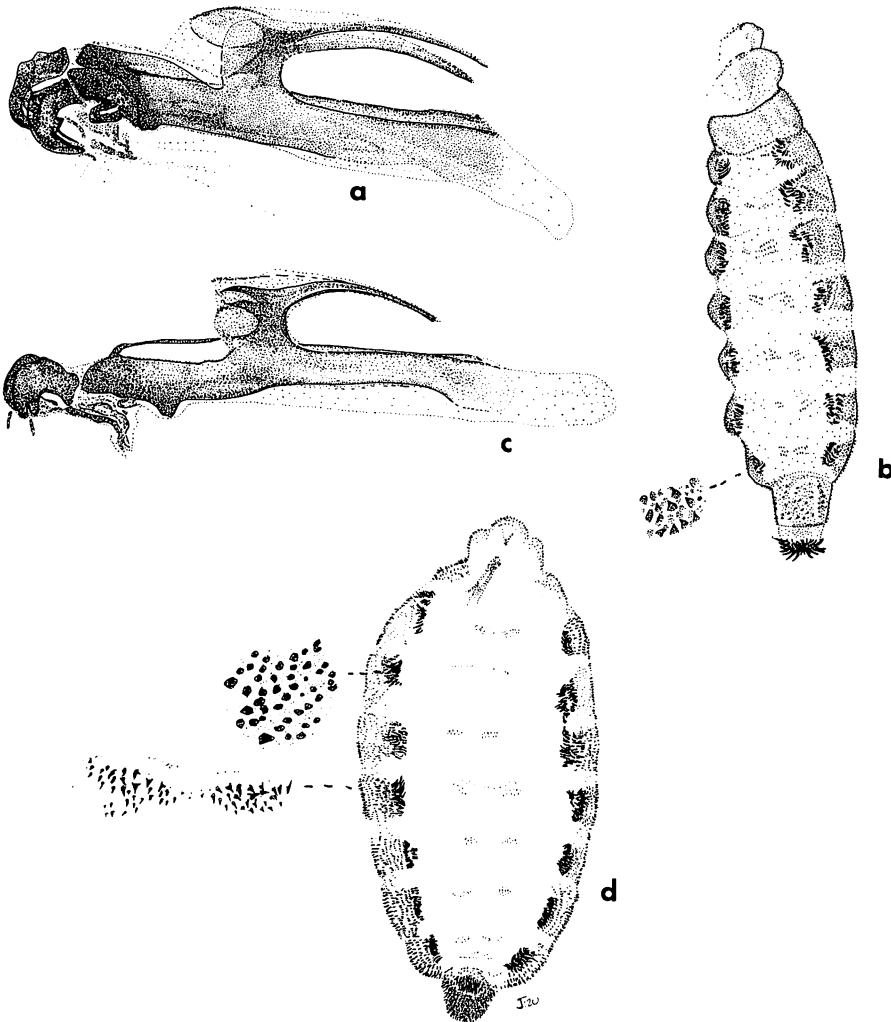


Figure 159—*Procanace acuminata* Hardy and Delfinado, n. sp., immature stages: a, cephalopharyngeal skeleton, third instar larva; b, larva; c, cephalopharyngeal skeleton from puparium; d, puparium.

cephalopharyngeal skeleton about 0.39 mm. long, almost black except for posterior ends of ventral and dorsal cornua; mouthhooks stout, with blunt teeth (fig. 159a).

Puparia (figs. 159c,d): Dark brown, broad fusiform. Very similar to that of *nigroviridis* but differs by having transverse multiserial ventral spines. These spines are arranged in multiserial circle in *nigroviridis*, and the lateroventral spines are not as prominent as in *acuminata*. Length about 3.25 mm.; 1.50 mm. at its greatest width. Integument pebbly and roughly spinose, with a group of multiserial, strong spines on each of segments 1-7 lateroventrally; ventral abdominal spines arranged in 4-6 transverse rows which are interrupted medially. Anterior and posterior spiracles invaginated and very difficult to see.

Holotype male and allotype female Kapue Stream, Hawaii, east slope of Mauna Kea, 1000 ft., May 29, 1970 (M. D. Delfinado). 120 paratypes, both sexes from the following localities: same as type (M. D. Delfinado and J. A. Tenorio); Pahoehe, on rocks in swift moving stream, Hawaii, 750 ft., May 29, 1970 (M. D. Delfinado and J. A. Tenorio); Iao Valley, Maui, on wet rocks in swift moving stream, June, 1952, and March 28, 1970 (D. E. Hardy and J. A. Tenorio); Makamakaole Valley, Maui, March 31, 1970, on wet rocks along stream, 1100 ft. elevation (D. E. Hardy); above Rainbow Falls, Hawaii, on rocks in swift stream, May 28, 1970 (J. A. Tenorio); Kaiwiki Stream, Hawaii, December 27, 1969 (J. A. Tenorio); Honomu Maiki Stream, Hawaii, February 28, 1970 (J. A. Tenorio); Wailua, Maui, June, 1953 (C. R. Joyce); approximately 300 specimens (not designated as paratypes) collected on wet rocks in swift waters below Moaula Falls, Halawa Valley, Molokai, March 16, 1970 (D. E. Hardy, J. A. Tenorio, and M. D. Delfinado).

Type, allotype, and a series of paratypes at B. P. Bishop Museum. Paratypes distributed among the following collections: U.S. National Museum, British Museum (Natural History), and University of Hawaii.

***Procanace bifurcata* Hardy and Delfinado, new species (figs. 160a-e)**

Fitting very close to *confusa* n.sp. and differentiated by the development of the surstylus of the male. The outer lobe is broad, straight-sided and rounded at apex as in figure 160d, rather than with outer lobe curved upward, tapered at apex with apical portion thinner, more translucent than remainder of lobe (fig. 161c). We see no other characters for differentiating this species. The female terminalia are similar to those of *confusa* n.sp. (figs. 160a-c,e). The mesonotum and scutellum are chocolate-brown pollinose and a distinct green sheen is evident on face and front.

Comparatively small species: Male, body, 2.5 mm.; wings, 2.35 mm. Female, body, 2.6 mm.; wings, 2.5 mm.

Holotype and allotype female, Opaecula Stream, Oahu, 1150 ft., June 12, 1970 (M. D. Delfinado). Sixty-two paratypes both sexes about equally represented from the following localities on Oahu: mostly same data as type;

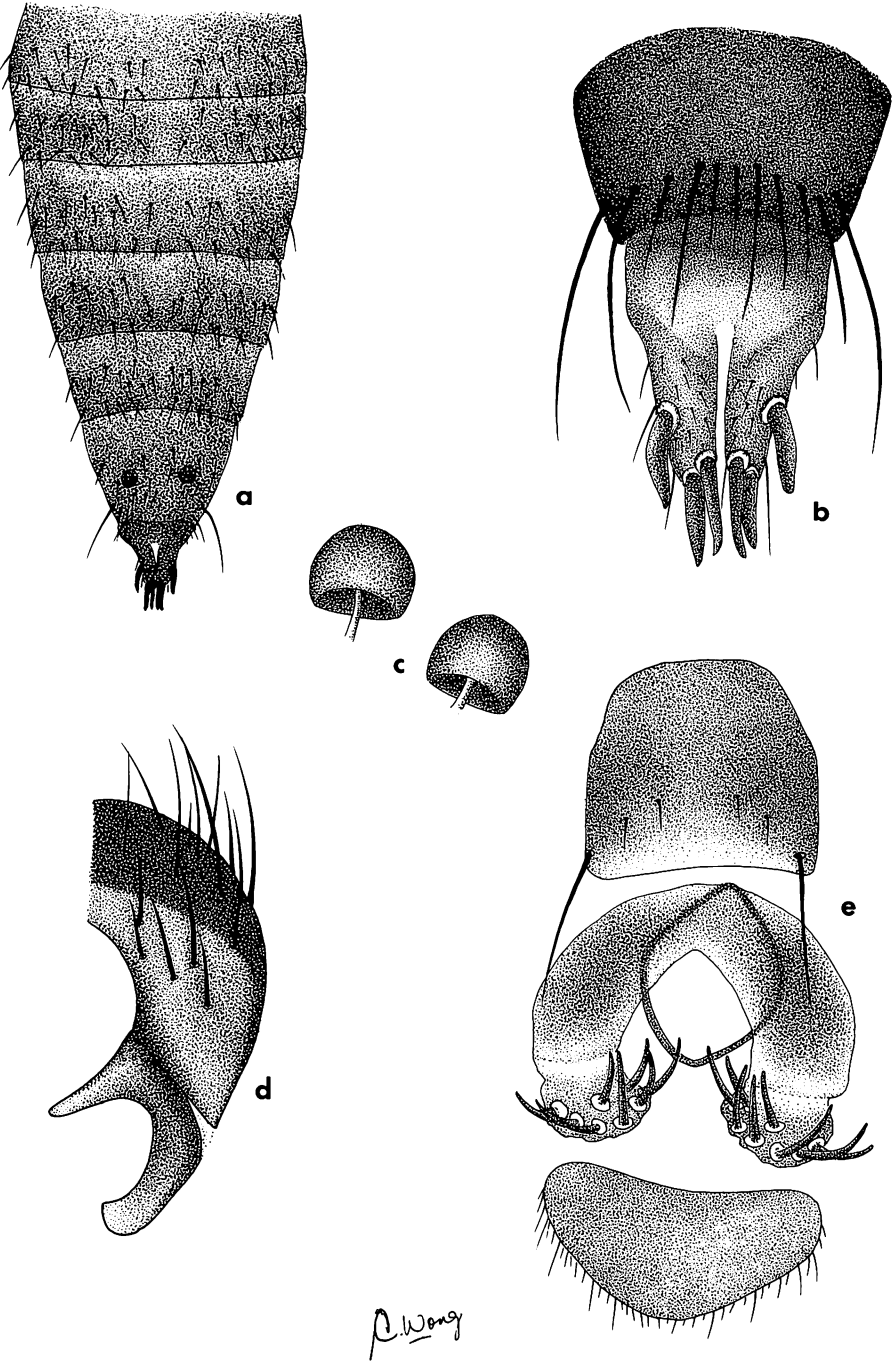


Figure 160—*Procanace bifurcata* Hardy and Delfinado, n. sp.: a, female abdomen, dorsal; b, female post abdomen, dorsal; c, spermathecae; d, male surstylus; e, post abdomen of female, ventral.

Kawai-iki Stream, June 12, 1970 (M. D. Delfinado); Kahalanui Stream, May 26, 1970 (M. D. Delfinado); Manoa Valley, January, 1952, 1953 (M. S. Adachi and D. E. Hardy); head of Kalunui Valley, Oahu, May, 1951 (D. E. Hardy); Punaluu Stream, May 24, 1962 (J. A. Tenorio); Waihinui, Manoa, Honolulu, August 13, 1933 (F. X. Williams); Waihi-iki, Manoa Valley, March 22, 1936 (F. X. Williams). Kauai: Hanakapiai, mouth of River nr beach; August 10, 1971 (M. D. Delfinado and D. E. Hardy).

Type, allotype, and a series of paratypes at B. P. Bishop Museum. Paratypes distributed among the following collections: U.S. National Museum, British Museum (Natural History), and University of Hawaii.

***Procanace confusa* Hardy and Delfinado, new species (figs. 161a-e)**

This species is found in the same habitat with *acuminata* n.sp. but belongs in an entirely different subgroup of the *nigroviridis* complex. It is immediately differentiated from *acuminata* by having the abdominal segments of the female normal in size and the surstylus of the male developed into two large lobes (fig. 161c). It is further differentiated by having the mesonotum chocolate-brown pollinose and by having a faint greenish, slightly metallic sheen over the front and the face (as seen in strong light). Based on the male terminalia, two species apparently occur in this subgroup, *bifurcata* from Oahu and Kauai, and *confusa* from Maui, Hawaii, and apparently Molokai. These are differentiated by the shape of the surstylus as shown in figures 160d and 161c. The outer lobe of the surstylus is curved gently on dorsal margin and slightly tapered at apex with the apical portion being thinner, more translucent than the remainder of the lobe. In *bifurcata* the outer lobe is straight, not curved and broad, rounded at apex. We see no other features to differentiate these.

MALE. In addition to the above characteristics each surstylus is bilobed, with a broad U-shaped concavity between the lobes, the surstyli are narrowly connected to the epandrium. Other features of genitalia are as in figure 161c.

Length: body, 3.25 mm.; wings, 3.0 mm.

FEMALE. Abdomen normal, basal segments not enlarged. Cerci tapered distally, each with two large and one slender apical spines. Eighth tergum with a prominent bristle on each posterolateral margin and a row of short and long setae along hind margin. Seventh sternum about as broad as long, slightly narrowed anteriorly, with a bristle on each posterolateral corner. Posterior plates of eighth sternum each with five long, slender spines. Ninth sternum about two times wider than long, rounded on posterior margin, and rather densely covered with short setae. Atrial sclerotization (wall of genital chamber) nearly oval in outline. Two rounded spermathecae, each with a short neck (fig. 161b). Other details of genitalia as in figures 161d,e.

Length: body, 3.5 mm.; wings, 3.25 mm.

Larvae: The larvae, as well as pupae, are readily recognized by the presence of a thickened horny process on segment seven; by the ill-defined windows on ventral and dorsal cornua, and by the arrangement of the ventral spines.

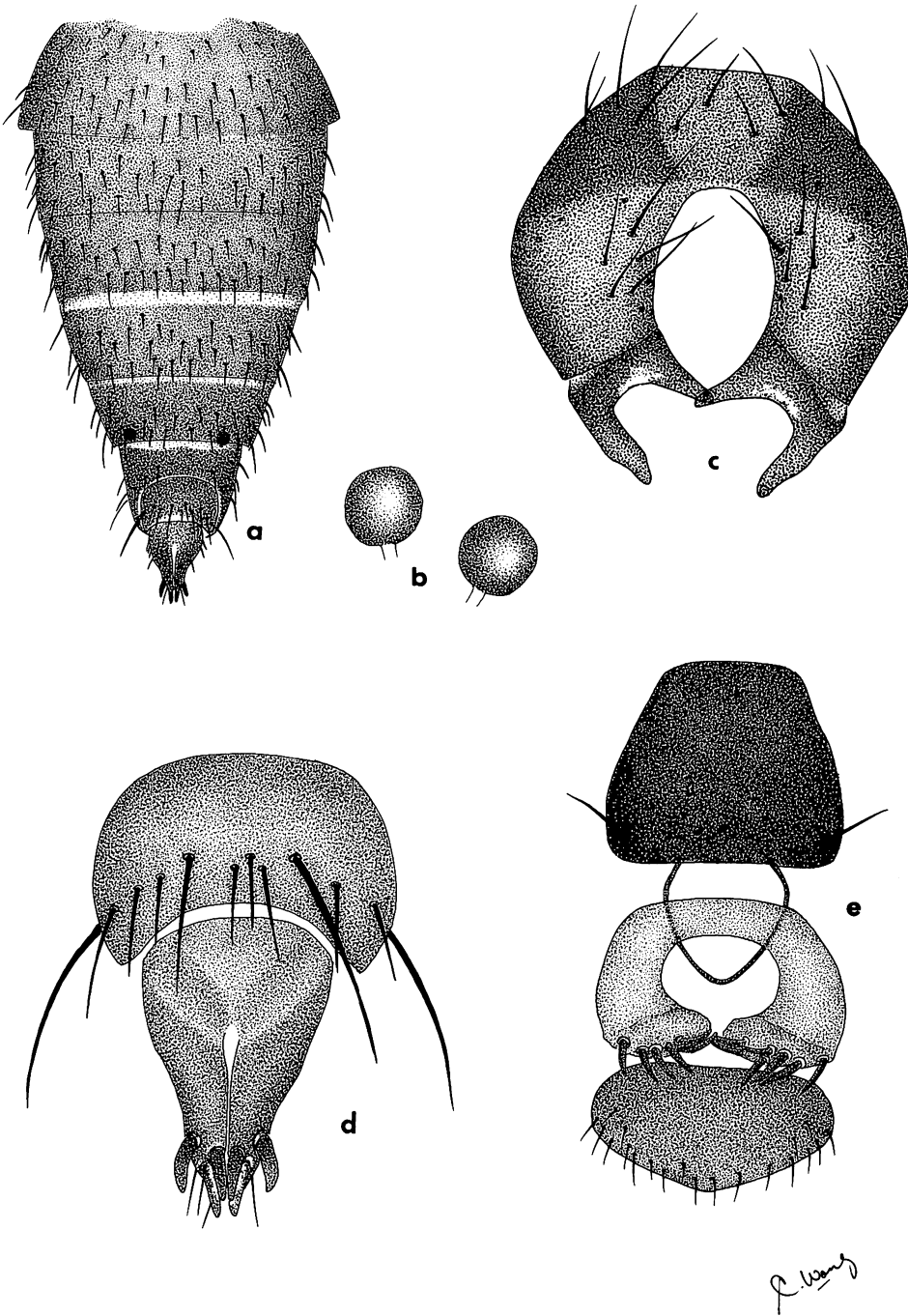


Figure 161—*Procanace confusa* Hardy and Delfinado, n. sp.: a, female abdomen, dorsal; b, spermathecae; c, male genitalia; d, female post abdomen, dorsal; e, female post abdomen, ventral.

Length, 3.0–3.25 mm.; 0.75–1.0 mm. greatest width. Body slender fusiform, pale green, pebbly dorsally, spinose laterally and lateroventrally, the lateroventral spines being longer. Abdominal ventral spines more pronounced than in pupa, consisting of 3–5 multiserial transverse rows of larger spines and a separate row of minute spines anteriorly. Segment 7 with a horny, thickened process on each lateral margin. Anterior spiracles extruded, bifurcate. Posterior spiracular tubes partly extruded. Terminal segment with the usual multiserial long spines. Cephalopharyngeal skeleton dark brown to blackish except for posterior end of ventral cornua. Dorsal cornua very slender, pointed posteriorly; ventral cornua broad, straight, with ill-defined small windows. Dorsal bridge well developed; parastomal sclerite (bar) present. Mouthhooks large, curved bidentate with sharp teeth, without windows.

Puparia: Length, 2.5 mm.; 1.0–1.25 mm. at greatest width. Body broadly fusiform, flattened ventrally, dark brown. Integument pebbly dorsally, spinose laterally and lateroventrally, the lateroventral spines being longer. Ventral abdominal spines consisting of 3–5 multiserial transverse rows of large spines and a separate row of minute spines anteriorly. Segment 7 with a thickened horny process on each lateral margin. Anterior spiracles extruded, bifurcate as in the larva; posterior spiracular tubes invaginated. Terminal segment with the usual group of long spines.

Holotype male and allotype female, stream above Akaka Falls, Hawaii, June 19, 1964 (D. E. Hardy). Approximately 200 paratypes from the following localities on Hawaii: same as type; Wailuku River, March–July, 1971 (M. D. Delfinado and J. A. Tenorio); Pahoe Stream, May 29, 1970 (M. D. Delfinado and J. A. Tenorio); Kapue Stream, May 29, 1970 (M. D. Delfinado and J. A. Tenorio). Maui: Iao Valley, on wet rocks in swift running stream, June, 1952, September, 1968, March 28–31, 1970 (D. E. Hardy and J. A. Tenorio); Kipahulu Valley, Seven Sacred Pools, February 21, 1970 (D. E. Hardy); Kopiliula Stream, Maui, August, 1970 (D. E. Hardy, M. D. Delfinado, and J. A. Tenorio); Waihee Stream, May, 1952 (M. Tamashiro); Wailua, June, 1953 (C. R. Joyce), and Waiakani Falls, roadside water dripping, March 26, 1970 (J. A. Tenorio).

A series on hand from Halawa and Wailau valleys, Molokai, also appear to be this species, but do show slight differences in the terminalia and are not being included in the type series.

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. Paratypes being distributed among the collections of the U.S. National Museum, British Museum, and the University of Hawaii.

***Procanace constricta* Hardy and Delfinado, new species (figs. 162a–e)**

This species is found in the same habitat with *confusa* n.sp. and *acuminata* n.sp. It is immediately differentiated from all known *Procanace* by having the female abdomen constricted medianly (fig. 162a); by the very short, broad cerci with inconspicuous apical spines (fig. 162b); the very narrow eighth tergum

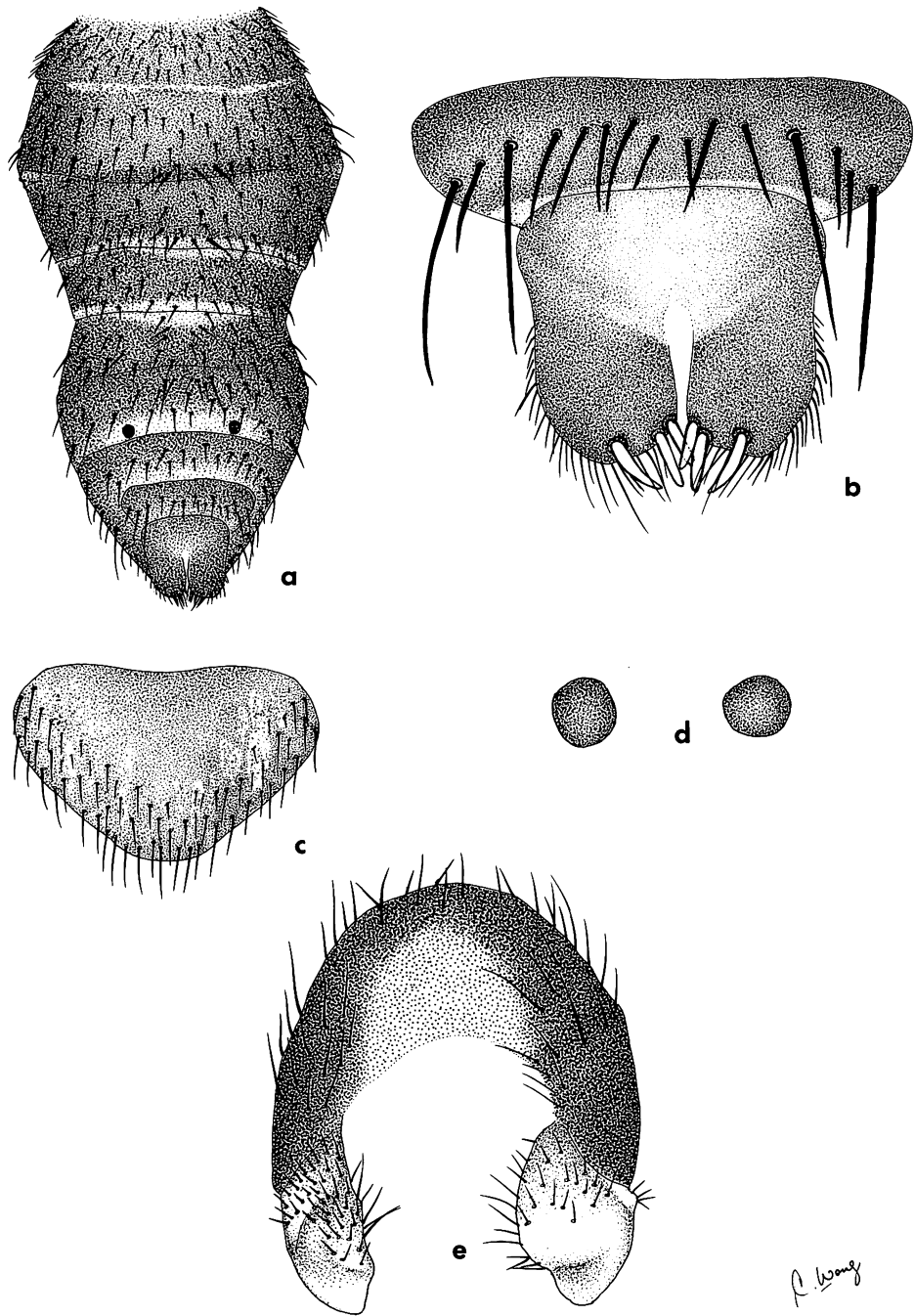


Figure 162—*Procanace constricta* Hardy and Delfinado, n. sp.: a, female abdomen, dorsal; b, post abdomen of female, dorsal; c, ninth sternum of female; d, spermathecae; e, male genitalia, end view, hypandrium and aedeagus not shown.

and by having the ninth sternum very large, complete and angulate posteriorly (fig. 162c). Also, the broad leaflike distal spines usually present on third and fourth tarsomeres of all legs in other species are present only on front tarsi in *constricta*. The males fit near *nigroviridis*, but the genital characters are very different (see key and figs. 162e, 163c).

FEMALE. Very similar to *nigroviridis*, having the mesonotum and scutellum brown pollinose with a faint green sheen, also front distinctly metallic green in strong light. Abdomen with first two terga normal in shape, closely joined, appearing fused when seen *in situ*. Conspicuously constricted between terga four and five (fig. 162a). Cerci short and broad, as wide as long, each with three small apical spines and with rather long hairs around ventral apical margin. Eighth tergum about four and one half times wider than long and with a marginal row of long and short hairs, with the outermost hairs being the longest. Seventh tergum very narrow dorsally and expanded on lateroventral margins, extending posteriorly to bases of cerci. Terga five and six also expanded on lateral margins but not so greatly as in seventh. Ninth sternum large, covered with very short hairs and with posterior margin produced medially (fig. 162c). Posterior plates of eighth sternum each with five to eight spines. Spermathecae round (fig. 162d).

Length: body, 3.0-3.25 mm.; wings, 3.75 mm.

MALE. Fitting very close to *nigroviridis*, differentiated only by genital characters, although the specimens on hand do have a much more distinct green sheen over the face as well as the front and in specimens of *nigroviridis* (from Kauai) face is gray, with a very faint sheen of green. *P. constricta* is differentiated by having the surstyli broadly rounded at apices as seen in end view (fig. 162e), not slightly tapered; also, the hypandrium is very differently formed, developed into two upcurved arms on venter.

Holotype female and allotype male, Halawa Valley, Molokai, collected on wet rocks in swift moving stream, July, 1952 (D. E. Hardy). Thirty-five paratypes, from following localities: same as type; March 16, 1970 below Moaulu Falls, Molokai (D. E. Hardy and J. A. Tenorio); Wailua Stream gauge, Molokai, 605 ft., June 4, 1970 (J. Kjargaard); Kopiliula and Waikane Streams, Maui, April 9, 1970 (M. D. Delfinado and D. E. Hardy); and Wailuku River, Hawaii, June 22, 1971 (J. A. Tenorio and M. D. Delfinado).

Type, allotype, and some paratypes in B. P. Bishop Museum. Other paratypes in collections of U.S. National Museum and University of Hawaii.

***Procanace nigroviridis* Cresson (figs. 163a-g)**

Procanace nigroviridis Cresson, 1926, Proc. Haw. Ent. Soc. 6:277. Type male in B. P. Bishop Museum.

The male genitalia of the type have been studied.

Endemic. Kauai. (Type-locality: Awaawapuhi.)

A complex of species breed on algae-covered rocks in swift water mountain streams in Hawaii. The species described by Wirth (1951:254) as *nigroviridis*

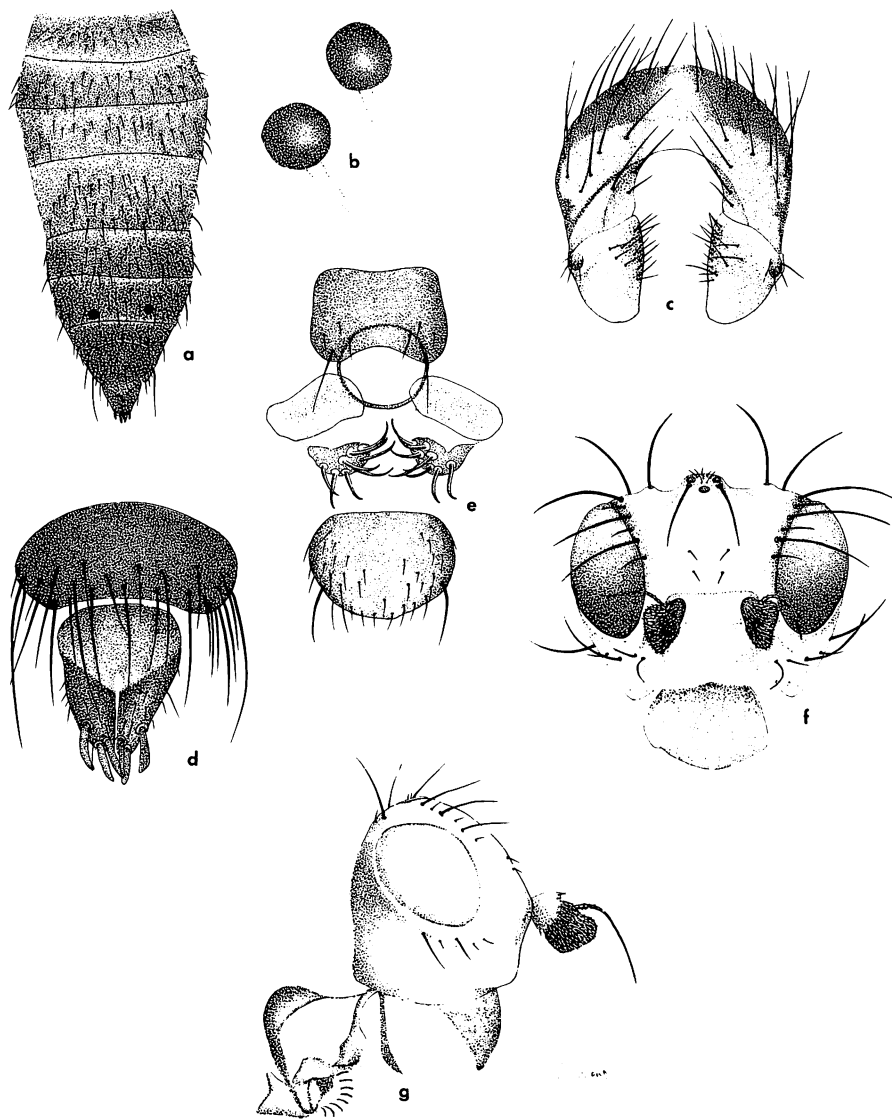


Figure 163—*Procanace nigroviridis* Cresson: a, female abdomen, dorsal; b, spermathecae; c, male genitalia, end view, hypandrium and aedeagus not shown; d, female post abdomen, dorsal; e, female post abdomen ventral; f, head, front view; g, head, lateral.

was obviously based upon specimens from Oahu which represent a new species. The notes on immature stages and biology by Williams (1938:110, figs. 46, 48–50) also do not pertain to *nigroviridis*; all of his specimens in the Hawaiian Sugar Planters' collection were from Oahu and Molokai.

The *nigroviridis* complex of species is differentiated by the larger size;

predominantly dull black color, including the squamae and halteres; nearly bare mesofrons, with only a few setae on lower portion; usually with two strong genal bristles; absence of acrostichal setae; by the very large clypeus, almost equal in length to the face (fig. 163f,g); and by the dark, smoky-brown wings. *P. nigroviridis* has the mesonotum covered with chocolate-brown pollinosity and front mesonotum and scutellum overcast with a metallic olive-green sheen. The species are differentiated by the male terminalia and by the modification of the first two abdominal terga and terminalia of the females.

P. nigroviridis has the surstylus of the male completely articulated, free from the epandrium, broad, evenly tapered to a blunt apex as seen in lateral view, and with a small rounded secondary process situated near base on ventral surface of margin so that this is visible in lateral or ventral views but hidden in dorsal view. Inner surface of each surstylus rather densely setose on basal half (fig. 163c). Tenth sternum small, scarcely visible externally as a small appendage extending anteriorly on each side from opposite base of surstylus. Hypandrium divided into two lobes on each side of ventral margins. Aedeagus rather simple, slightly enlarged apically. Sixth sternum narrow, about three times wider than long. Female abdomen with terga 1-4 expanded, the remaining segments abruptly narrowing posteriorly (fig. 163a). Terga 1-2 fused, seventh sternum rather small, slightly wider than long, concave posteriorly, with one long seta on each posterolateral corner and three short setae on each side beyond middle of sclerite. Eighth sternum with eight long slender spines on each posterior plate. Ninth sternum very large, complete, wider than long, rounded posteriorly, covered with short, strong setae (bristles) and with one long bristle-like seta on each lateral margin (fig. 163e). Eighth tergum with two irregular rows of short and long setae, the outermost setae are the longest (fig. 163d). Cerci slightly tapered posteriorly, each with two very large apical spines and one slender subapical spine; also with short, stout spinules dorsally and with two long apical hairs and several short setae. Two rounded spermathecae, without necks, but with long filamentous ducts ending in short sclerotized openings (fig. 163b).

Length: body and wings, 2.5-3.0 mm.

Larvae: No specimens are available for study although Williams (1937:110) gave a brief description. Cephalopharyngeal skeleton (taken from a puparium) dark brown or blackish. Dorsal cornua very slender, slightly curved and pointed posteriorly; ventral cornua broad, straight in lateral aspect, no windows. Mouthhooks large, deeply bidentate with sharp teeth and small windows.

Puparia: As figured by Williams (1937, pl. 7, fig. 48). Length about 3.25 mm.; greatest width about 1.50 mm. Brown, fusiform, flattened ventrally. Integument pebbly dorsally, spinose laterally and lateroventrally; these spines being stronger and curved towards venter. Ventral abdominal spines arranged in multiserial circle on segments 2-7, those on segment 1 in 4-5 multiserial transverse rows. Anterior and posterior spiracles invaginated and difficult to see.

***Procanace quadrisetosa* Hardy and Delfinado, new species (figs. 164a-c)**

A series of female specimens on hand from Kauai appears to represent a distinctly new species which fits in the group which has the abdominal terga normal in development and the spermathecae without necks. They differ distinctly from other known species by having the eighth tergum comparatively narrow, over two times wider than long, concave on postero-median margin and with four strong posterior bristles (fig. 164a); also, the filamentous ducts of the spermathecae are not sclerotized at the ends as in *wirthi* and *nigroviridis*. It is readily differentiated, *in situ*, by the strong bristles on the eighth tergum.

FEMALE. Very similar to *nigroviridis*. Front with the copper-green sheen and face gray, sometimes with a faint greenish sheen in strong light. Also mesonotum and scutellum brown pollinose with a faint greenish sheen in strong light. Second abdominal tergum scarcely longer than first or third and closely joined with first, fused over dorsal surface. Seventh tergum with a broad U-shaped concavity in middle of hind margin in which fits the narrow eighth tergum, the latter as in figure 164a, with four prominent bristles and four small setae along each hind margin. Cerci rather short, triangular, with the inner margins parallel, straight and rather sharply pointed apically; distinctly longer than wide, each with three rather weak spines at apex, and with two long and scattered short setae on ventral apical margin (fig. 164a).

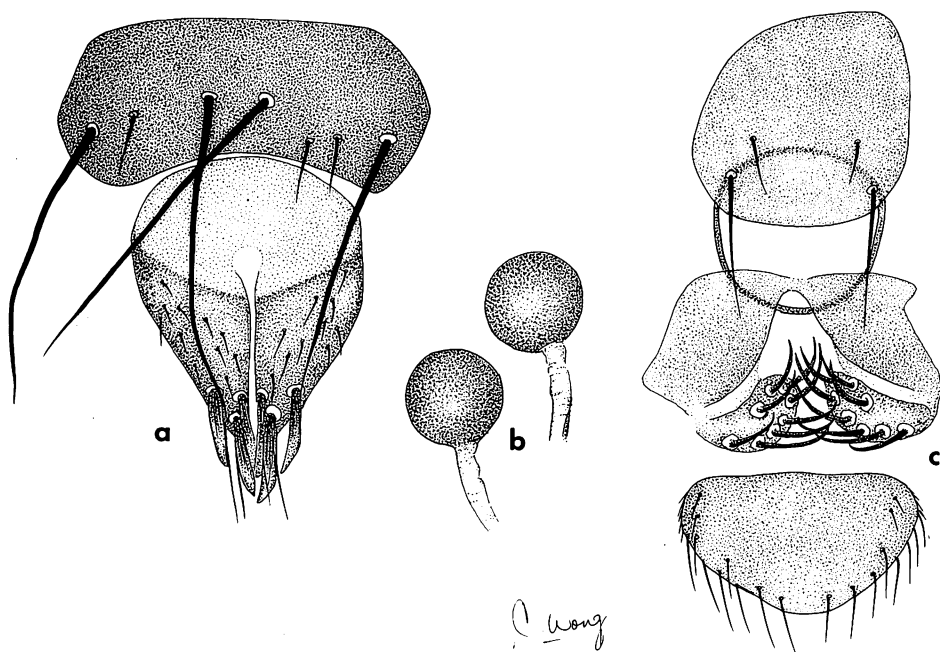


Figure 164—*Procanace quadrisetosa* Hardy and Delfinado, n. sp.: a, female post abdomen, dorsal; b, spermathecae; c, female post abdomen, ventral.

Sterna 1-6 comparatively broad, well developed, at least one-half to two-thirds the width of seventh sternum. Seventh sternum large, slightly longer than wide, with a prominent bristle on each posterolateral margin and with posterior margins straight. Eighth sternum with a prominent V-shaped cleft in middle of hind margin, dividing the sclerite into two plates. The posterior plates of eighth sternum each with nine long slender spines. Ninth sternum over two times wider than long, straight on anterior margin; angulate posteriorly and fringed with fairly long coarse setae along posterior margin (fig. 164c). Atrial sclerotization round in outline. Two rounded spermathecae without necks but with long filamentous ducts (fig. 164b).

Length: body, 4.0 mm; wings, 3.7 mm.

The male has not yet been associated.

Holotype female and one female paratype, Waipoo Falls, Waimea Canyon, Kokee, Kauai, on wet rocks, April 2, 1970 (M. D. Delfinado). One female paratype, Wailua Falls, Kauai on wet rocks, April 4, 1970 (M. D. Delfinado).

Type in B. P. Bishop Museum, paratypes in University of Hawaii collection.

***Procanace williamsi* Wirth (figs. 165a-f)**

Procanace williamsi Wirth, 1951, Occ. Pap. B. P. Bishop Museum. 20:257.

Type-locality: Kalihi, Honolulu, Oahu.

Oahu.

Immigrant. Japan (Ref. Miyagi, 1965:96).

A small, dark gray species differentiated by having the frons setose (figs. 165e,f) and 2-4 irregular rows of acrostichal setae extending from anterior margin almost to a level with posterior pair of dorsocentrals; clypeus short, less than half as long as face; and halteres and squamae yellow. Also by the distinctive male genitalia (fig. 165c).

Body black in ground color, gray pollinose, tinged with brown over mesonotum. Front slightly narrowed anteriorly, dull gray pollinose, with three pairs of strong, divergent fronto-orbital bristles and with mesofrons covered with numerous strong setae. Face and genae gray pollinose, tinged reddish-brown in ground color of sides of face.

Four pairs of strong dorsocentral bristles, the posterior pair slightly displaced laterally. Mesonotum with numerous strong setae scattered over the surface mostly in front of a line drawn between the supraalar bristles, except for two rows of acrostichals extending almost to a level with the posterior dorsocentrals. Both notopleural bristles almost as strong as humerals. Wings subhyaline. Male aedeagus completely developed. Surstylus bilobed, with the outer (anterior) lobe slender, almost straight-sided and the inner lobe expanded and with long fine hairs on hind margin. Also with a prominent, expanded lobe extending beyond anteroventral margin of epandrium, which from the internal connections is obviously representative of the 10th sternum. Female with four prominent setae on hind margin of eighth tergum. Cerci each with

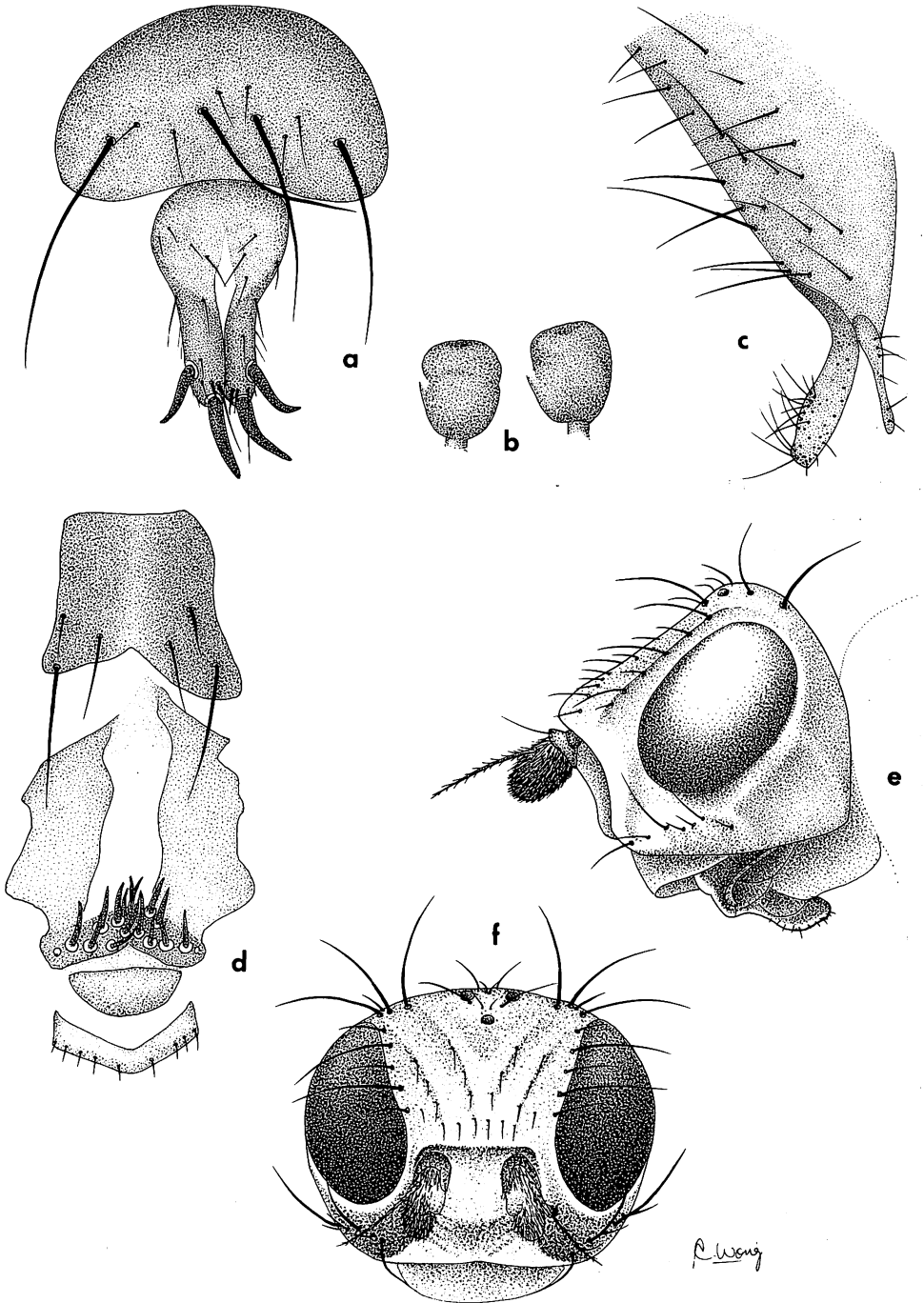


Figure 165—*Procanace williamsi* Writh: a, female post abdomen, dorsal; b, spermathecae; c, surstylus of male; d, female post abdomen, ventral; e, head, lateral; f, head, frontal view.

two strong dorsoapical spines (fig. 165a). Other details of the female as in figures 165b,d.

Length: body and wings, 1.8 mm.

***Procanace wirthi* Hardy and Delfinado, new species (figs. 166a-e)**

A very distinctive species; the males are differentiated from others known from Hawaii by the boomerang shape of surstyli (fig. 166d). The females have the abdominal terga normal in development, and fit near *nigroviridis* Cresson because of the nature of the spermathecae. It is readily separated from *nigroviridis* by the characters given in the key above.

This is the species which Wirth described as *nigroviridis* (1951:254, figs. 2a-c). His specimens were obviously from Oahu. The biological notes by Williams (1938:110) under *nigroviridis* pertains to two or more species.

MALE. Front black with a faintly greenish sheen as seen in strong light, also a very faint tint of green over face. Mesonotum and scutellum dark gray pollinose, no greenish sheen. Front tarsomeres 3 and 4 each with a flattened lanceolate spine ventrally. Surstyli distinctly separated from epandrium, boomerang-shaped (fig. 166d) with fine short hairs on inner median portion and with very small secondary lobes on outer basal portion.

Length: body and wings, 3.5 mm.

FEMALE. Second tergum slightly enlarged, about one-third to one-half longer than one or three. The first two are very closely joined (fig. 166a), appearing fused, *in situ*. Cerci very short and broad, about as wide as long, each with three scoop-like spines distally (fig. 166c) and with a row of marginal setae ventrally. Ninth tergum large, about as long as wide, slightly concave on posterior margin and with four large, bristle-like setae plus nine short setae arranged in irregular rows over posterior portion. Seventh tergum with a broad V-shaped concavity in middle of hind margin, fitting around edges of eighth tergum. Sterna 1-4 very narrow, consisting of a thin brown streak extending along venter of abdomen. Seventh sternum very large, widest anteriorly, with 1-2 long setae on each posterolateral margin and convex medianly on posterior edge. Eighth sternum with eight long spines on each posterior plate. Ninth sternum with a deep median V-shaped cleft on interior margin, almost dividing the sclerite; rather densely setose posteriorly (fig. 166e). Spermathecae without necks but with a short sclerotized section at end of each filamentous duct before entering the main duct (fig. 166b).

Length: body, 3.8-4.0 mm.; wings, 3.5 mm.

Holotype male and allotype female, Maunawili Stream, Oahu, 800 ft. elevation, on wet rocks, April 15, 1970 (M. D. Delfinado). Forty-five paratypes, sexes mixed, mostly same data as type; also from the following localities on Oahu: Punaluu Stream, November 28, 1937, June 12, 1968 (F. X. Williams and D. Ashdown); Waianae, July, 1936, swift water stone ditch (F. X. Williams); Waihi-iki, Manoa Valley, March 22, 1936 (F. X. Williams); Kalihi Stream, March 13, 1957, wet boulder (F. X. Williams);

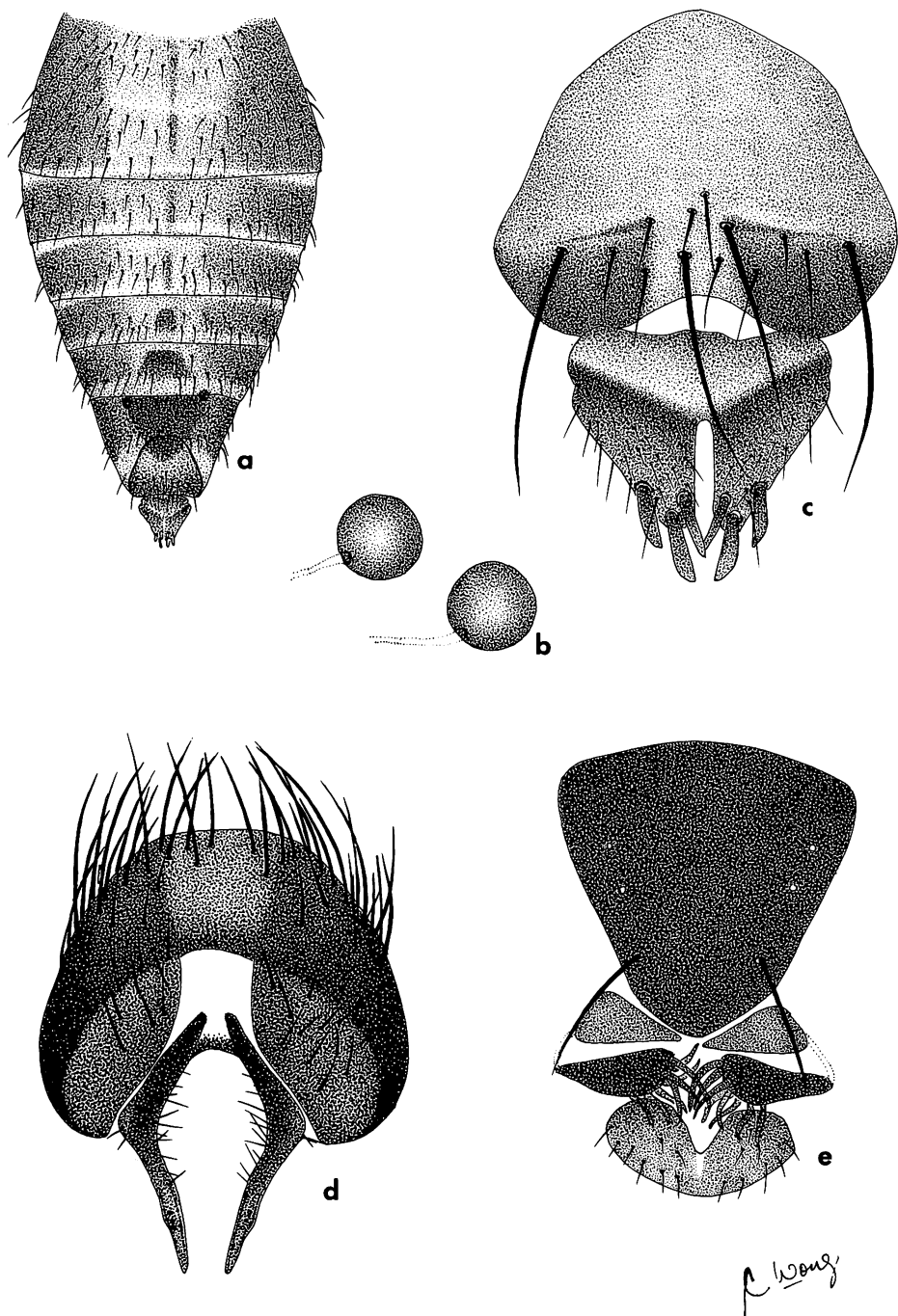


Figure 166—*Procanace wirthi* Hardy and Delfinado, n. sp.: a, female abdomen, dorsal; b, spermathecae; c, female post abdomen, dorsal; d, male genitalia, end view; e, female post abdomen, ventral.

Kaluanui Stream, 2000 ft., October 18, 1936 (F. X. Williams); Konahuinui, on stream rocks, May 12, 1935 (F. X. Williams); and Hering Valley, Tantalus, Honolulu, July 30, 1933, wet rocks by waterfall (F. X. Williams). Kauai: Hanakapiai River, sea level to 600 ft., August 10, 1971 (D. E. Hardy and M. D. Delfinado).

Type, allotype, and a series of paratypes in B. P. Bishop Museum, other paratypes in collections of U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

A series of specimens on hand from Kalalau Valley, Kauai, appear to be this species; however, they show some differences in the genital characters and may represent a distinct species. We are waiting until we are able to get more information, including immature stages, before this question is decided.

This species is named after Dr. Willis W. Wirth, U.S. National Museum, who has contributed a great deal to our knowledge of the Canaceidae as well as many other groups of Diptera.

Procanace unnamed species

A single female specimen from Wailuku River, Hawaii, 50 ft. elevation, June 23, 1971 (J. A. Tenorio), apparently is undescribed. It shows relationship to *nigroviridis* Cresson and *constricta* n.sp. and is closest to the latter. It differs by having the third tergum completely separated medianly and the ninth sternum sparsely setose.

Family CHLOROPIDAE

The Frit Flies

Rather small, sparsely bristled flies characterized by the cubital cell lacking in the wing; subcostal vein rudimentary, fused with R_1 apically; cells M and 1st M_2 united; costa broken only at end of Sc; frontal triangle very large, usually shining and often extending to anterior margin of front; postocellar bristles convergent; antennae short, third segment rounded and arista short pubescent or bare in Hawaiian species; legs short, tibiae lacking preapical dorsal bristles.

The larvae are mainly plant feeders and some species are serious agricultural pests in other areas. Some visit flowers (e.g. *Oscinella formosa* Becker) and are probably important pollinators. Some are predators (*Thaumatomyia glabra* [Meigen]) and some (not in Hawaii) are annoying pests and important vectors of infectious eye diseases.

The common name, frit fly, comes from one species, *Oscinella frit* Linnaeus, a notorious and widespread pest of wheat. Wheat ruined by the flies were called "frits" by the Swedish farmers at the time Linnaeus described the species.

For a world list of type species of Chloropidae refer to Sabrosky (1941a and 1964).

KEY TO GENERA AND SPECIES

1. Costa extending to apex of vein $M_1 + 2$ (fig. 170c).
 Subfamily Oscinellinae. 2
 Costa extending only to apex of $R_4 + 5$ (fig. 167b).
 Subfamily Chloropinae. 9
- 2(1). Hind tibia with a strong, curved, preapical or apical
 ventral spur (figs. 170a, 172a). 3
 Hind tibia lacking such a spur. 4
- 3(2). Nearly all yellow species, with the spur of hind tibia
 large, subequal to basitarsus (fig. 170a).
 **Cadrema pallida** (Loew).
 Mostly black species, tibial spur comparatively
 small, extending only slightly past base of basitar-
 sus (fig. 172a). **Hippelates** Loew. 3a
- 3a. Thorax densely gray pollinose, especially dorsally.
 Only frontal triangle polished black, sides of front
 yellow on lower half. Antennae and abdomen all
 black. **hermsi** Sabrosky.
 Thorax polished black. Front black except for
 yellow lower margin. Third antennal segment
 mostly yellow to rufous, brown along dorsal
 margin. Basal two segments of abdomen yellow. .
 **collusor** (Townsend).
 (not known to be established)
- 4(2). Scutellum normal, not enlarged. Last section of vein
 $M_1 + 2$ straight, (fig. 179c). 5
 Scutellum enlarged, three-fifths as long as meso-
 notum and with bases of bristles on prominences
 (fig. 176c). Last section of $M_1 + 2$ curved upward
 beyond m crossvein (figs. 176e, 177c). Front and
 body polished black. **Rhodesiella** Adams. 4a
- 4a. Legs mostly black, except for yellow tarsi. Third
 section of costa, between tips of veins R_1 and
 $R_2 + 3$, rather short scarcely over one-half to two-
 thirds as long as fourth section. Halteres with
 black knobs. 4b
 Legs all yellow. Third section of costa about equal in
 length to fourth (fig. 176e). Halteres yellow-
 white. Scutellum very large (fig. 176c).
 **elegantula** Becker.
- 4b. Tiny species, body 1.4–1.5 mm. Hind femur not

- enlarged and lacking ventral spines near base. Vein $M_1 + 2$ not curved sharply upward just beyond m crossvein. Male genitalia as in figures 178a,b. **sauteri** (Duda).
- Moderate-sized species, body 2.25–3.0 mm. Hind femur swollen, with two short, stout, ventral spines near base (fig. 177d). $M_1 + 2$ curved sharply upward just beyond m crossvein (fig. 177c). Male genitalia as in figures 177a,b. **scutellata** (de Meijere).
- 5(4). Vein $R_2 + 3$ extending well beyond a level with m crossvein so that the third costal section is equal to or longer than fourth section. Species lacking striated gray pubescent markings over front and mesonotum. 6
- Vein $R_2 + 3$ very short, ending about opposite m crossvein and third costal section about one-fourth as long as fourth section (fig. 179c). Black species with conspicuous striated gray markings over front and mesonotum (fig. 179b). **Siphunculina striolata** Wiedemann.
- 6(5). Scutellum rounded, slightly convex, wider than long, with four prominent scutellar bristles. Body shining black or small all-yellow species, except for brownish tinge on abdomen. 7
- Scutellum flat, as long as wide, the bristles on tubercles and the secondary pair rudimentary (fig. 175b). Thorax densely gray pubescent with three faint brown vittae on mesonotum. Head and appendages yellow, except for eyes. **Meijerella flavisetosa** Sabrosky.
- 7(6). Body entirely black, frontal triangle black. 8
- Small entirely yellow species except for tinge of brown on abdomen. Front with a row of prominent yellow setae along each orbit and one along each margin of frontal triangle. **Oscinella formosa** Becker.
- 8(7). Mesonotum and scutellum entirely shining black, densely pale setose. Frontal triangle opaque. Third antennal segment reniform (fig. 171a). Vein $M_1 + 2$ angled sharply upward beyond m crossvein (fig. 171b). Coxae and femora black. **Gaurax bicoloripes** (Malloch).

Thorax sparsely setose. Scutellum gray pollinose and with a gray pollinose triangle extending about half length of mesonotum from hind margin through dorsocentral area (fig. 173b). Frontal triangle polished. Third antennal segment round. Vein $M_1 + 2$ not strongly angled beyond m (fig. 173a). Coxae and femora yellow. .

..... **Monochaetoscinella anonyma** (Williston).

- 9(1). Third antennal segment not elongate, either circular or but slightly longer than wide (fig. 167a). Body and legs mostly yellow. 10

Third antennal segment nearly four times longer than wide (fig. 168c). Body and femora black. . . .

..... **Neoloxotaenia gracilis** (de Meijere).

- 10(9). Arista short pubescent (fig. 167a). Crossvein m well spaced from r-m, last section of vein $M_3 + 4$ much shorter than penultimate section of $M_1 + 2$ (fig. 167b). 11

Arista densely, short, black plumose, giving it a strap-like appearance (fig. 167d). Crossvein m situated very close to r-m, penultimate section of $M_1 + 2$ less than half as long as m crossvein (fig. 167e). **Semarangia dorsocentralis** Becker.

- 11(10). Mesonotum with three broad, polished black vittae; abdomen mostly shining black; third antennal segment black, nearly circular in shape. **Thaumatomyia glabra** (Meigen).

Nearly all yellow to rufous species, no black markings. Third antennal segment slightly pointed apically and just slightly longer than wide (fig. 167a). **Chloropsina citrivora** Sabrosky.

Subfamily CHLOROPINAE

Members of this subfamily are differentiated by having the costa extending only to apex of vein $R_4 + 5$ (fig. 167b).

Three genera occur in Hawaii.

Genus **CHLOROPSINA** Becker

Chloropsina Becker, 1911, Annls hist.-nat. Mus. natn. hung. 8:413. Type-species, *oculata* Becker, the first species. By designation of Malloch 1931d:76.

The one species recorded in Hawaii is readily differentiated from other

Chloropinae by being almost entirely yellow, lacking black markings on the body; also by the shape of the third antennal segment as shown in figure 167a, and crossvein r-m situated slightly before middle of cell 1st M_2 (fig. 167b).

***Chloropsina citrivora* Sabrosky (figs. 167a-c)**

Chloropsina citrivora Sabrosky, 1976, Pacif. Insects 17(1):95. Type-locality: Hilo, Hawaii.

Oahu, Molokai, and Hawaii, probably on the other main islands. First recorded in Hawaii as *Chlorops* sp.?, from Oahu by Hardy (1952d:408). Probably an immigrant species. This species has been reared from citrus (rough-skinned lemon) seedlings at the Hilo tree nursery, Hawaii (Hardy, 1958). The larvae were actively boring in the roots of the young plants; these were dead and dying and it could not be definitely ascertained as to whether the flies were primary or secondary invaders.

It is differentiated from other species in Hawaii by the characters given under the genus above. Head as seen in lateral view as in figure 167a with the front margin protruded and third antennal segment distinctively shaped: slightly pointed apically with the arista preapical and with the third segment distinctly longer on ventral than on dorsal margins. Thorax mostly yellow with a narrow brown vitta behind suture on each side of mesonotum, a dark brown longitudinal mark along lower margin of each mesopleuron, a brown mark on each humerus, and with mesonotum dark brown to blackish. Also, a rather prominent brown to black mark occupies the anteromedian portion of mesonotum immediately behind head. Mesonotum and scutellum densely covered with short, black setae. Apical scutellar bristles moderately developed, about one-third to one-half longer than vertical bristles and rather widely spaced. Secondary scutellars small, scarcely two times larger than the setae on the disc. Wings as in figure 167b. Legs entirely yellow, wings hyaline, r-m crossvein situated just before middle of cell 1st M_2 and third costal section about one-third longer than fourth. Abdomen entirely yellow to rufous, tinged with brown on sides of terga. The genitalia are shaped as in figure 167c. The surstyli are broad, serrated on apical margin.

Length: body, 2.25-2.5 mm.

Genus *NEOLOXOTAENIA* Sabrosky

Loxotaenia Becker, 1911, Annls hist.-nat. Mus. natn. hung. 9:83 (preocc. Herrich-Schaeffer, 1854. Type-species, *Lagaroceras gracile* de Meijere, by original designation.

Neoloxotaenia Sabrosky, 1964, Ent. News 75:180 (new name for *Loxotaenia* Becker). Type-species, *Lagaroceras gracile* de Meijere, automatic.

Differentiated from other Chloropinae in Hawaii by the elongate third antennal segment; all black body and femora; white halteres; and by the vertical band of silvery-gray extending over the sternopleuron, mesopleuron, and sides of mesonotum between suture and humerus. The head is shaped as in

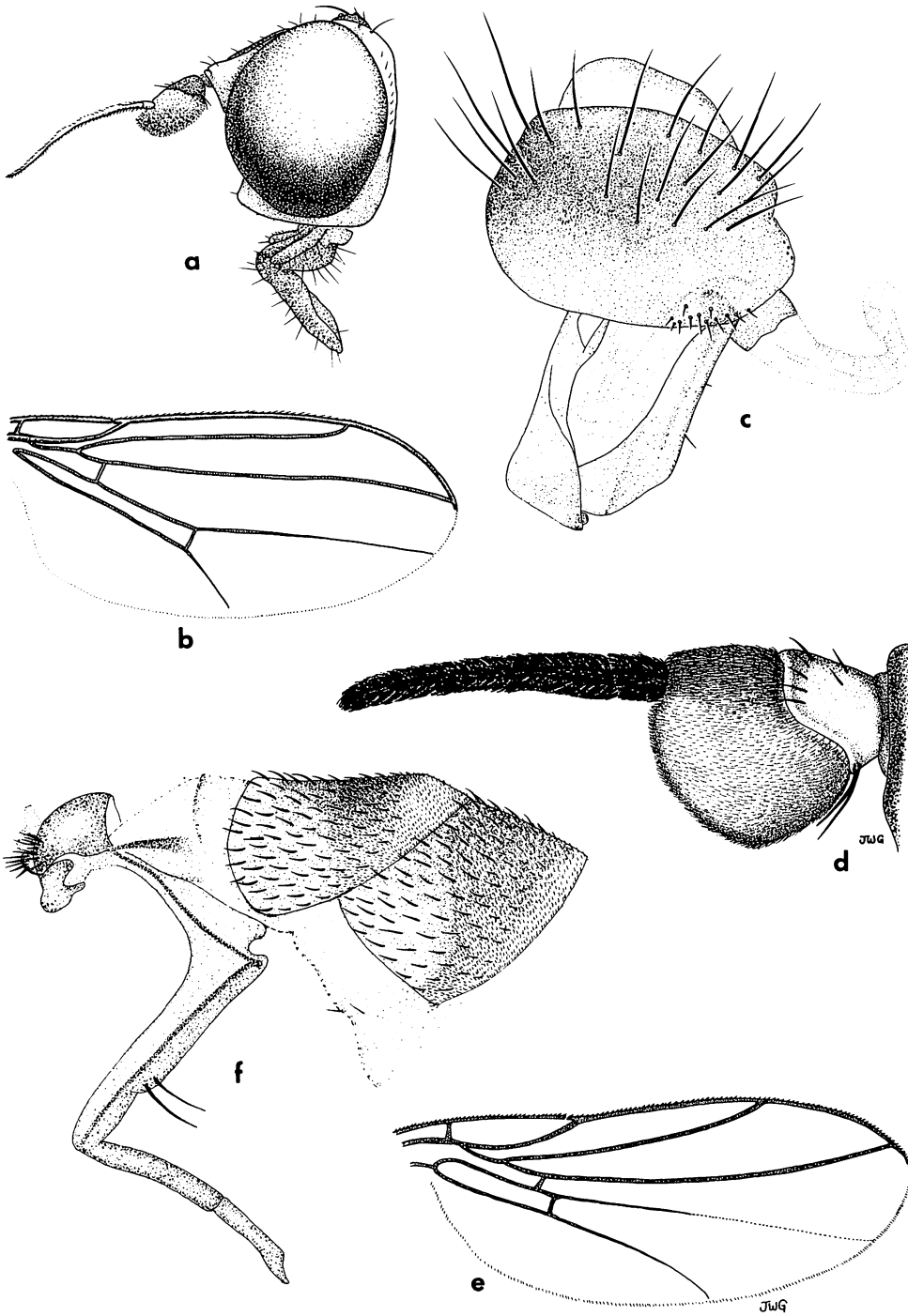


Figure 167—*Chloropsina citrivora* Sabrosky: a, head, lateral; b, wing; c, male genitalia, lateral. *Semaranga dorsocentralis* Becker: d, antenna; e, wing; f, posterior portion of male abdomen and genitalia, lateral.

figure 168c and the arista are bare. The head and thoracic bristles are lacking except for a rudimentary postalar and a pair of small apical scutellars.

Only one species occurs in Hawaii.

***Neoloxotaenia gracilis* (de Meijere) (figs. 168a-c)**

Lagaroceras gracile de Meijere, 1908, Tijdschr. Ent. 51:170. Type-locality: Semarang, Java.

Oahu, Kauai.

Immigrant. Java, Sumatra, Formosa, and the Philippines. First reported by Joyce (1968:19); the earliest collection date is March, 1964.

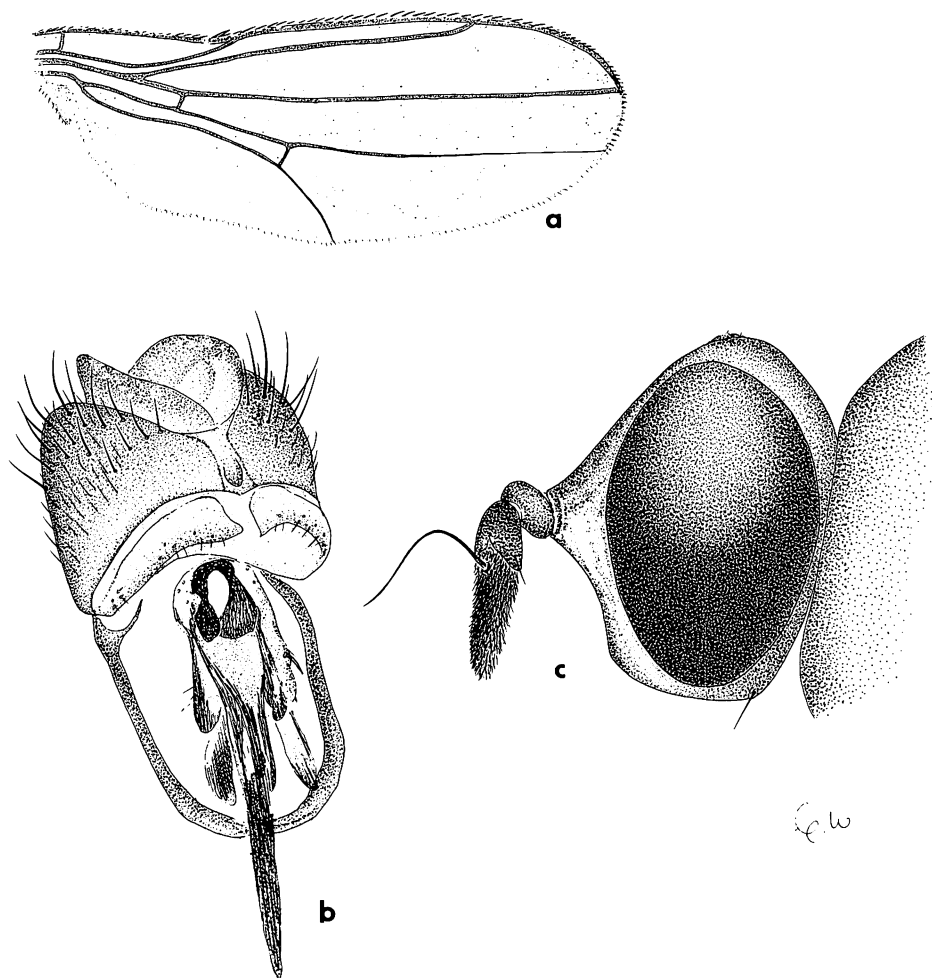


Figure 168—*Neoloxotaenia gracilis* (de Meijere): a, wing; b, male genitalia, ventral; c, head, lateral.

Easily differentiated from other Hawaiian chloropids by the generic characters given above. An all black species except for yellow tibiae and tarsi, yellow ground color of frontal orbits, around bases of antennae, and with yellow tinge in median portion of face. Front vertex and ocellar triangle polished black, except for the orbits which are yellow, tinged with brown and covered with gray pubescence. Face shining yellow-brown down median portion densely gray pubescent on sides. Antennae black, tinged with yellow at base of third and apex of second segments. Mesonotum mostly dull brown pollinose subshining to shining black on anterior portion. Scutellum gray pollinose with only the apical scutellars developed, the secondary pair rudimentary, seta-like. Wings hyaline, venation as in figure 168a. Crossvein r-m situated at middle of cell 1st M_2 . Wings densely covered with microtrichia. Abdomen with sides of terga broadly polished and dorsal portion opaque dark brown to black. Genitalia as in figure 168b, the cerci short and narrow, six or more times higher than long; surstyli poorly developed and aedeagus short and thick.

Length: body, 2.75–3.0 mm.

Genus **SEMARANGA** Becker

Semarang Becker, 1911, Annls hist.-nat. Mus. natn. hung. 9:48. Type-species, *dorsocentralis* Becker, by monotypy.

Differentiated by having the arista very densely, short, black plumose, appearing strap-like (fig. 167d) and the m crossvein situated very near r-m (fig. 167e).

Semarang dorsocentralis Becker (figs. 167d–f)

Semarang dorsocentralis Becker, 1911, Annls hist.-nat. Mus. natn. hung. 9:48. Type-localities: Semarang, Java, and Bombay, India.

Oahu. Known only from light trap specimens. First collected, Honolulu, May 19, 1969 (Joyce, 1977).

Immigrant. Widespread over Oriental Region, Africa, and USSR (Maritime Territory).

A small, mostly yellow to rufous species resembling *Chloropsina citrivora* Sabrosky in general appearance. It is readily differentiated from all known Hawaiian chloropids by the generic characters given above. Head and appendages clear yellow except for the compound eyes, the shiny ocellar triangle, the aristae, dark brown upper margin of third antennal segment and rufous labella. Thorax rufous dorsally, yellow on sides, with a small black spot near median hind margin of each humerus and a thin dark brown to black line down each dorsocentral row, almost entire length of the mesonotum. Two dorsocentral bristles, one located at the suture and one near hind margin. Scutellum yellow, with four bristles on hind margin, the apical pair over two times stronger than the subapical pair. Legs almost entirely yellow, front tarsi

tinged with brown. Wings hyaline, venation as in figure 167e. Halteres pale yellow. Abdomen entirely rufous with faint tinge of brown on the terga. Male genitalia as in figure 167f. The aedeagus very large, plainly visible *in situ*, as long as abdomen and not contained within the genital chamber. Aedeagus two-jointed, with a pair of strong black bristles on ventral margin on each side of basal portion (fig. 167f).

Length: body 2.25 mm.

Genus **THAUMATOMYIA** Zenker

Thaumatomyia Zenker, 1833, Miscellen (Froriep's) 35:344. Type-species, *prodigiosa* Zenker, by monotypy, = *notata* (Meigen).

For synonymy refer to Stone, et al. (1965:787).

This is differentiated from other Chloropinae in Hawaii by having the thorax highly polished, yellow with broad black vittae down mesonotum, and with body almost devoid of bristle or hairs. Scutellars represented by a pair of closely spaced setae at apex. Arista microscopically pubescent.

A distinct elongate-oval sensory structure is present on postdorsal surface of hind tibiae.

Refer to Sabrosky (1936, 1943) for synopsis of Nearctic species.

Thaumatomyia glabra (Meigen) (figs. 169a,b)

Chlorops glabra Meigen, 1803, Syst. Besch. europ. Zweif. Ins. 5:149.

For synonymy refer to Stone, et al. (1965:787).

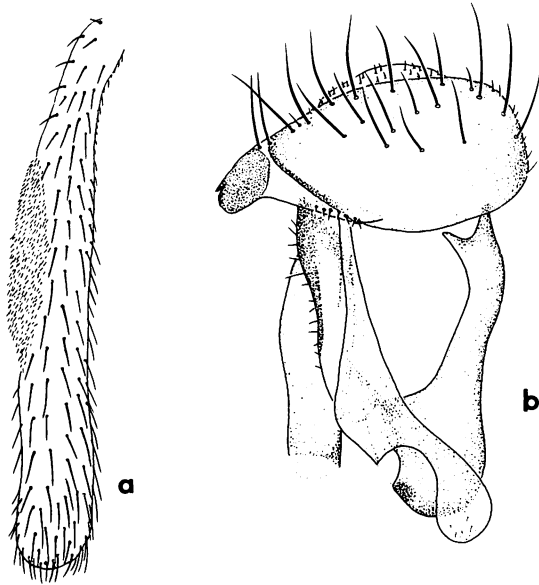


Figure 169—*Thaumatomyia glabra* (Meigen): a, hind tibia; b, male genitalia, lateral.

Hawaii.

Immigrant. Europe; widespread over Nearctic region, northern Mexico. Known in Hawaii (Hardy, 1972) from only one female specimen collected at Puuwaawaa, N. Kona, Hawaii, 3700 ft., August 24, 1917 (W. M. Giffard).

The larvae are predaceous upon root aphids and, according to Sabrosky (1936:170), "are especially important predators of the sugar beet root aphid, *Pemphigus betae* Doane." Sabrosky (1943b:114) says "*T. glabra* is the commonest species of the genus and almost cosmopolitan in its recorded distribution."

Head almost quadrate in shape, completely yellow except for the compound eyes, shining brown to black frontal triangle and dark brown to black sides of epistoma. Genae rather broad, about one-third to two-fifths the eye height. Thorax yellow except for three broad, polished black vittae extending down mesonotum and onto laterobasal margins of scutellum, a polished brown to black mark along lower margin of each sternopleuron extending onto pteropleuron, and with lower two-thirds of sternopleuron tinged with brown. Scutellum bare except for scattered microscopic yellow setae, with the apical bristles very closely spaced. Legs entirely yellow, except for brown to black front basitarsi; the sensory structure on posterodorsal surface on hind tibia elongate, extending two-fifths the length of the segment (fig. 169a). Wings hyaline, with r-m crossvein situated near apical two-thirds of cell 1st M₂. Abdomen with terga predominantly shining, dark brown to black over the dorsum, yellow on sides and with narrow apex of fourth and broad apex of fifth yellow. Male genitalia as in figure 169b; the surstyli are short, inconspicuous, with short teeth at apices.

Length: body, 2.5–3.0 mm.

Subfamily OSCINELLINAE

Differentiated by having the costa extending to apex of vein M₁ + ₂ (fig. 171b). Seven genera occur in Hawaii.

Genus CADREMA Walker

Cadrema Walker, 1859, J. Linn. Soc. Lond. 4:117. Type-species, *lonchopteroides* Walker, by monotypy.

Prohippulates Malloch, 1913, Proc. U.S. natn. Mus. 46:260. Type-species, *Hippelates pallidus* Loew, by original designation.

Members of this genus are characterized by the very strong, curved spur at apex of hind tibia (fig. 170a), in combination with the flat scutellum and the strong bristles on the head.

Only one species occurs in Hawaii.

Cadrema pallida (Loew) (figs. 170a–d)

Hippelates pallidus Loew, 1866, Berl. Ent. Z. (1885) 9:184. Type-locality: Cuba.

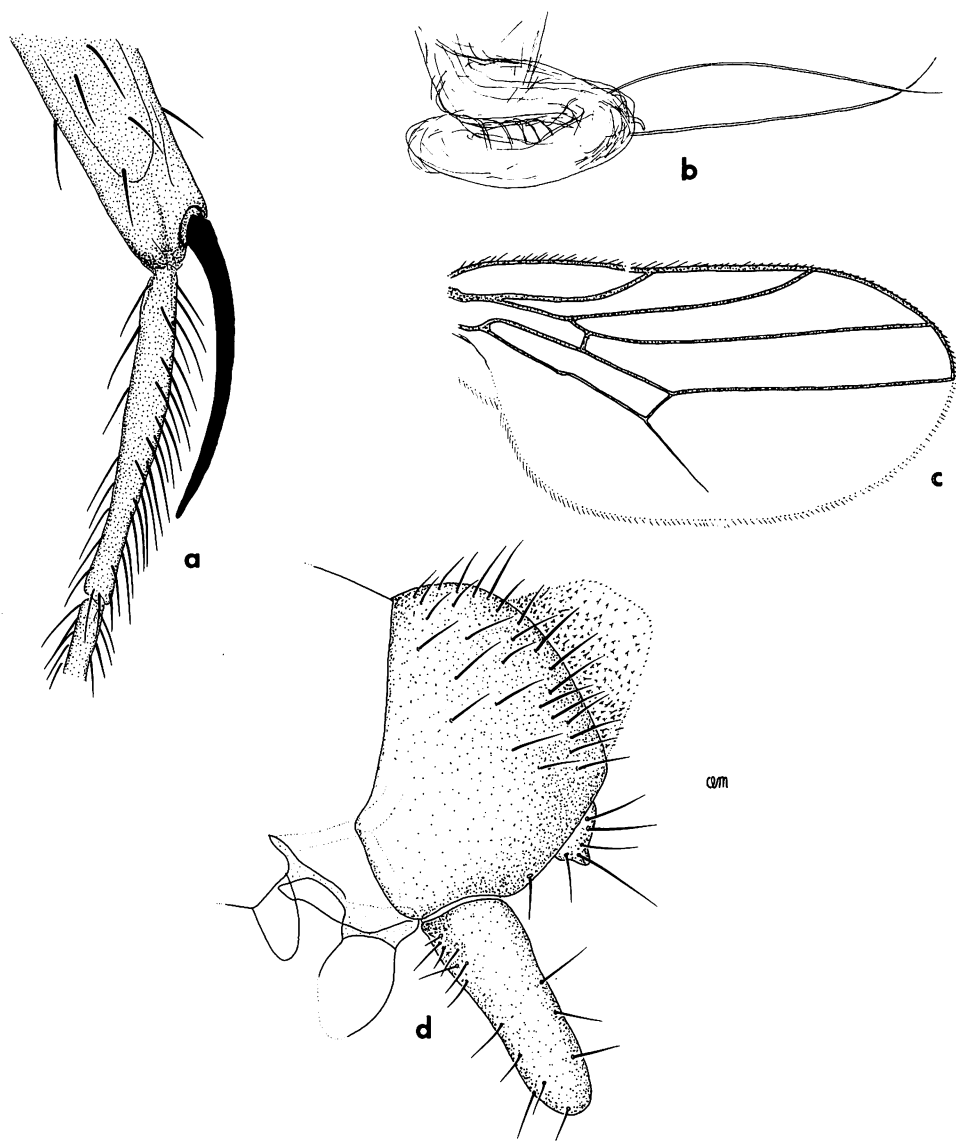


Figure 170—*Cadrema pallida* (Loew): a, hind tibia; b, labellum; c, wing; d, male genitalia, lateral.

This has been in the Hawaiian literature as *Hippelates nigricornis* Thomson (Bryan, 1926c:70 and 1939:235), as *Hippelates nigricornis* var. *flavus* Thomson (Butler and Usinger, 1963:243), and as *Prohippelates pallidus* (Loew) (Malloch 1930b:245; also Wirth, 1947:22). On all of the Hawaiian Islands.

First recorded from Palmyra Island in September, 1913, by Swezey (1914b:16) as *Hippelates* sp.

A widespread nearly Tropicopolitan species.

Typically all yellow, except for the eyes but showing considerable color variation, some specimens have the third antennal segment black and have two black vittae on mesonotum. This is differentiated from other chloropids in Hawaii by the large spur on hind tibia (fig. 170a). The head bristles are all well developed and are yellow or faintly tinged with brown. Four pairs of fronto-orbital bristles present and with a row of prominent hairs (bristles) on each side of frontal triangle. Frontal triangle extending almost full length of front and very sharply pointed anteriorly. Third antennal segment higher than long, kidney-shaped; arista short pubescent. Labella of male each with a long, yellow, ventral cilia near anterior margin (fig. 170b). Wings as in figure 170c. Male genitalia as in figure 170d; the surstyli are prominent, equal in length to the epandrium.

Length: body, 2.3–3.0 mm.; wings, 2.0–2.6 mm.

Genus **GAURAX** Loew

Gaurax Loew, 1863, Berl. Ent. Z. 7:35. Type-species, *festivus* Loew, by monotypy.

For synonymy refer to Stone, et al. (1965:781) and to Sabrosky (1951c:407).

Differentiated from other Hawaiian Oscinellinae by having the body entirely polished black and the coxae and femora black. Also by the reniform third antennal segment (fig. 171a), the short pubescent arista and by the wing venation (fig. 171b), and male genitalia (fig. 171c); the scutellum is typical in shape, wider than long, rounded, slightly convex on the disc and four scutellar bristles are present. The eyes are pilose, large, occupying most of the head, as seen in lateral view. The genae are very narrow. Fronto-orbital ocellar and vertical bristles are moderately well developed. The thorax is entirely polished black, densely short setose, with one pair posterodorsocentrals, one postalar and one humeral bristle. In most species of *Gaurax*, cell R is distinctly broader than cell R₃ and vein R₂ + ₃ is strongly curved in the one species represented in Hawaii; cell R₁ is about equal in width to the basal two-thirds of R₃ and vein R₂ + ₃ is gently curved.

Sabrosky (1951c:408) indicates that *Gaurax* are often found in forest areas; a number have been collected on trunks and branches of trees. There is little knowledge of the habits of the genus and he says "it seems likely that the larvae do not do any direct damage, but feed in the frass of other insects or on decaying plant tissues."

Refer to Sabrosky (1951c) for a revision of the Nearctic species.

Gaurax bicoloripes (Malloch) (figs. 171a–c)

Oscinosoma bicoloripes Malloch, 1935, B. P. Bishop Mus. Bull. 114:30. Type-locality: Vaituha, Eiao Island, Marquesas. Type in B. P. Bishop Museum.

Oahu, Maui, Kauai, probably on all of the main islands. Also from Palmyra Island.

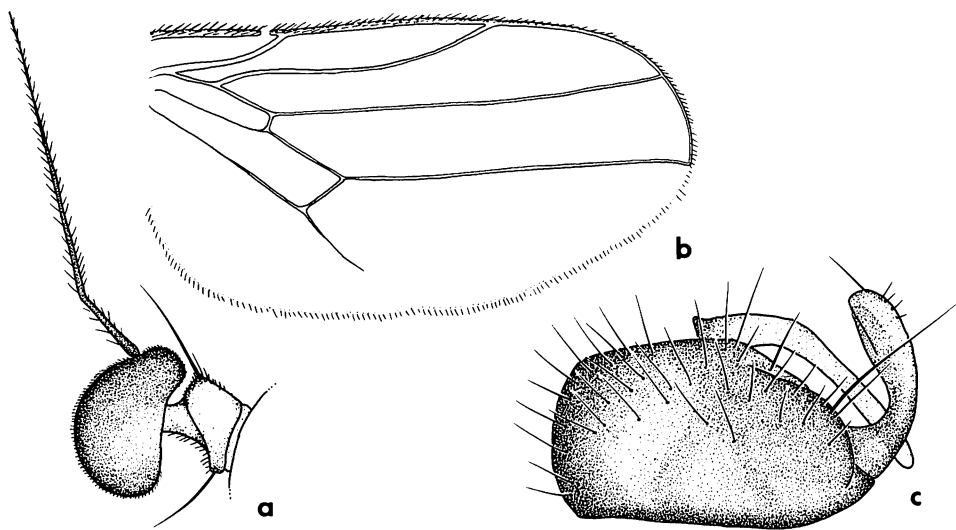


Figure 171—*Gaurax bicoloripes* (Malloch): a, antenna; b, wing; c, male genitalia, lateral.

Immigrant. First reported in Hawaii by Hardy (1952d:408). The earliest records for the islands are February, 1948, collected on Palmyra, and December, 1950, on Oahu.

A small, polished black species characterized by the black coxae and femora with yellow tibiae and tarsi. Eyes distinctly higher than long and genae very narrow. Third antennal segment higher than long (fig. 171a), the third tinged with yellow basally, and the second yellow. Palpi brown, tinged with yellow apically, mentum brown, labella yellowish. The mesonotum and scutellum are densely covered with short, erect, yellowish setae. Halteres entirely pale yellow. Apices of femora sometimes yellow. Wings hyaline, venation as in figure 171b; cell R_1 narrow compared to other *Gaurax* and vein $R_2 + 3$ straight or nearly so. The male genitalia are unusual in development; the surstyli are large and conspicuous, each with a basal lobe and with apical lobe enlarged, capitate (fig. 171c). A pair of long slender appendages arise from the dorsal median portion, just above the epandrium and their exact position cannot be ascertained. They apparently are attached to a chitinous strip which lies on the inner apical portion on each side of the epandrium and may be extensions of what is termed the tenth tergum in the Tephritidae. We are unable to demonstrate the cerci; these would appear to be entirely membranous and not discernible; or perhaps the long paired lobes could represent the cerci?

Length: body, 1.5–1.8 mm.

Genus **HIPPELATES** Loew

Hippelates Loew, 1863, Berl. Ent. Z. 7:35,36. Type-species, *plebejus* Loew, by subsequent designation (Coquillett, 1910:552).

For synonymy refer to Stone, et al. (1965:774).

Moderately small, typically shining black flies characterized by the short apicoventral spur on hind tibia (fig. 172a) in combination with the front bare except for short, inconspicuous orbital setae; and head bristles short, weak, inconspicuous.

Some of the species are very annoying eye gnats.

Refer to Sabrosky (1941b).

One species is common over the Hawaiian Islands and one has been recorded from Kure Island, but this probably is an error.

Hippelates collusor (Townsend)

Oscinis collusor Townsend, 1895, Proc. Calif. Acad. Sci. (2)4:619. Type-locality: Mexico (Baja Calif.).

Kure Island. One specimen found in a collection made by George Butler the summer of 1961 (Hardy, 1963). This is probably an error; we feel strongly that this record resulted from use of a contaminated cyanide bottle. Dr. Butler had previously collected in Arizona where this eye gnat is common.

Immigrant. Mexico, California, Nevada, Arizona, and Florida.

This is a very pestiferous species especially in the Coachella Valley of southern California.

This species was long confused with *pusio* Loew and, according to Sabrosky (1941b:26), the two are very similar.

According to Sabrosky (1941b:24), *collusor* is differentiated from *pusio* by having the legs, except for mid and hind coxae, typically deep yellow to orange, occasionally with some infuscation and the apical spur on the hind tibia "usually exceeding the apex of the tibia by nearly $\frac{1}{2}$ its length." *H. pusio* has "all coxae, femora, and the hind tibiae (in part) typically black or more or less infuscated, occasionally the legs chiefly orange, or with only coxae and middle femora basally blackened; hind tibial spur usually exceeds the apex of the tibia by $\frac{1}{4}$ - $\frac{1}{3}$ its length."

Hippelates hermsi Sabrosky (figs. 172a-c)

Hippelates hermsi Sabrosky, 1941, Can. Ent. 73:27. Type-locality: Coachella, California, U.S.A.

Oahu, Lanai, Molokai, and Maui. Probably on all of the main islands.

Immigrant. California, Nevada to Texas; also northern Mexico. First recorded in Hawaii by Hardy (1972). The earliest collection record is from Pukoo, Molokai, December, 1953.

Fitting in the dissidens groups of species by having the body black, thorax predominantly pollinose, and the hind tibial spur small, scarcely longer than the width of the tibia. In Sabrosky's key to species (1941b:25) it is differentiated by having the mesonotum entirely pollinose, the front coxae yellow, and remainder of legs chiefly yellow. The face, genae, palpi, and lower half of front are pale yellow. Frontal triangle polished black, extending approximately two-thirds length of front. Antennae entirely black. Gena approximately three-fifths-two-thirds as wide as third antennal segment. Propleura and lower half

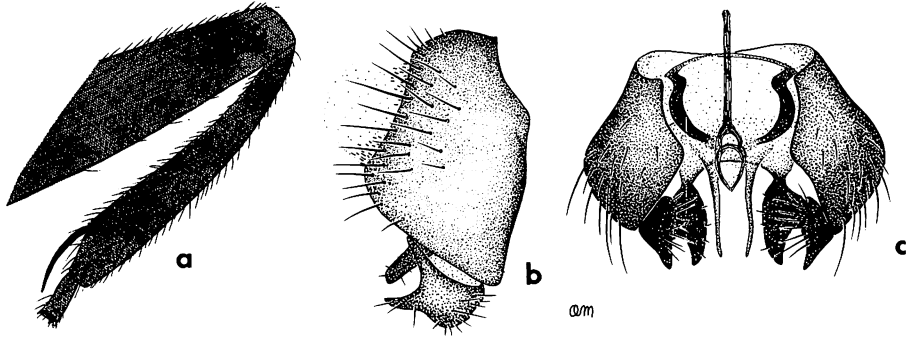


Figure 172—*Hippelates hermsi* Sabrosky: a, hind tibia; b, male genitalia, lateral; c, male genitalia, ventral.

of each pleuron polished dark brown to black, thorax otherwise pollinose. Front coxae and femora bright yellow, front tibiae, mid and hind femora and tibiae yellow, tinged with brown. Hind tibial spur as in figure 172a. The male genitalia are as in figures 172b,c, the surstyli are thick, broad, scarcely longer than wide and the lobes arising from just beyond the inner posterior margins of the epandrium are short and pointed.

Length: body, 1.25–1.5 mm.

We have no information on the habits of this species; numerous specimens have been collected on vegetation in a variety of habitats over the islands and some have been collected at lights.

Genus **MONOCHAETOSCINELLA** Duda

Monochaetoscinella Duda, 1930, Folia Zool. et Hydrobiol. 2:107. Type-species, *Oscinis anonyma* Williston, by subsequent designation (Duda, 1931:166).

In the classification of the Hawaiian Oscinellinae this would run near *Gaurax* Loew, but the two are not related. *Monochaetoscinella* is readily differentiated by having the mesonotum and scutellum sparsely setose, with scutellum gray pollinose, and a gray pollinose area over hind margin of mesonotum extending as a triangular marking on each side over dorsocentral area, typically about half the length of the sclerite (fig. 173b); also the notopleural area gray pollinose, thorax otherwise polished black; by having the frontal triangle entirely polished black and extending almost to anterior margin of front. Third antennal segment circular. One strong fronto-orbital bristle situated in middle of front. Wing venation distinctly different as in figure 173a. The male genitalia are small, rather inconspicuous.

***Monochaetoscinella anonyma* (Williston) (figs. 173a–d)**

Oscinis anonyma Williston, 1896, Trans. Ent. Soc. Lond. 1896:423.

Common over all the main Hawaiian Islands.

Immigrant. Widespread over southern U.S. and Neotropical region. First

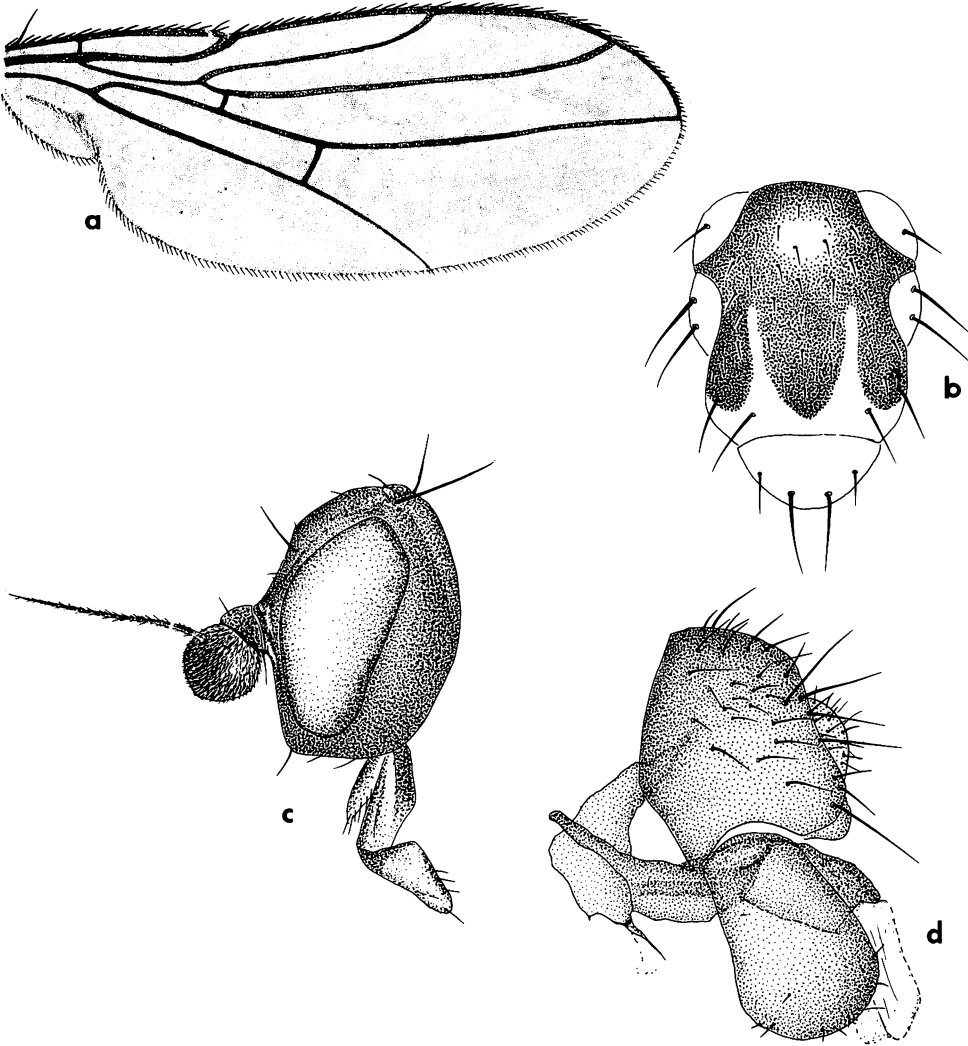


Figure 173—*Monochaetoscinella anonyma* (Williston): a, wing; b, dorsum of thorax; c, head, lateral; d, male genitalia, lateral.

recorded in Hawaii by Hardy (1972). The earliest collection record is Barbers Point, Oahu, January, 1962.

Differentiated from other Hawaiian species by the characters given under the genus above. Head shaped as in figure 173c. With one prominent fronto-orbital bristle plus two or three setae along each orbit. Antennae entirely black, palpi and mentum dark-brown to black. Eyes nearly circular, approximately as long as high and genae narrow, about half the width of third antennal segment. Thorax entirely polished black except for the pollinose markings mentioned above under generic discussion, the triangular markings on

posterior portion of mesonotum sometimes variable but typically extending about half the length of sclerite. The humeral bristles are rather poorly developed, only about two times longer than the surrounding setae. Two pairs notopleurals, one postalar, and one posterior dorsocentral are present. Apical scutellars strong, secondary scutellars rather weakly developed, only about two times stronger than the sparse setae over the scutellum or mesonotum. Wings hyaline. Venation as in figure 173a with vein $M_1 + 2$ nearly straight and r-m crossvein situated just beyond middle of cell 1st M_2 . Male genitalia as in figure 173d; the surstyli are broad and blunt, scarcely longer than wide; no processes are developed from the area posterior to the epandrium, as in some other genera of Chloropidae.

Length: body, 1.5–2.0 mm.

We have no information on the habits of this species; many of the specimens were collected in grass along stream margins.

Genus **OSCINELLA** Becker

Oscinella Becker, 1909, Bull. Mus. Hist. nat. (Paris) 15:120. Type-species, *deficiens* Becker, by monotypy.

Paroscinella Becker, 1913, Annls hist.-nat. Mus. natn. hung. 11:164. Type-species, *Oscinella acuticornis* Becker, by subsequent designation (Sabrosky, 1941a:761).

As discussed by Sabrosky (1951a:814), the generic concepts of *Oscinella* and related groups are somewhat confused and need clarification. It is easily differentiated from other Oscinellinae in Hawaii by its small size and having the head, thorax, and appendages entirely yellow. The scutellum is short and broad, rounded in outline with apical scutellars rather widely separated basally. The arista is very short pubescent and the third antennal segment nearly orbicular.

Oscinella formosa Becker (174a,b)

Oscinella formosa Becker, 1911, Annls hist.-nat. Mus. natn. hung. 9:154.

Type-locality: Takao, Formosa.

Oscinella pumila Becker, 1924, Ent. Mitt. 13:121. Type-locality: Formosa.

Oahu, Maui, Hawaii, and Kauai. Probably common over all the islands. First reported June, 1965 (Hardy, 1965 and 1967:326). Specimens in the U.S. National Museum collection from Oahu dated June 28, 1917.

Immigrant. Formosa, Micronesia.

This species occurs in abundance on the staminate flowers of coconuts (Sholdt, 1966:294). Two specimens from Kewalo, Oahu, May 4, 1914 contain a label "larvae at bases of sedges."

Tiny, all yellow species, except for brown on abdomen. Front and mesonotum shining. A row of four or five short yellow seta-like fronto-orbital bristles and also a row of short, yellow interfrontals along each side of triangle.

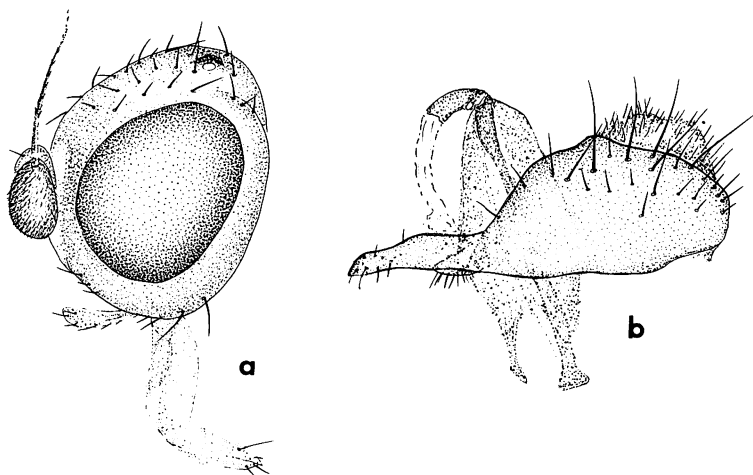


Figure 174—*Oscinella formosa* Becker: a, head, lateral; b, male genitalia, lateral.

Shape of head and antennae as in figure 174a. Male genitalia as in figure 174b, surstyli slender and epiandrium two times higher than long.

Length: body, 1.25 mm.

Genus **MEIJERELLA** Sabrosky

Meijerella Sabrosky, 1976, Pacif. Insects 17(1):91. Type-species, *Oscinella cavernae* de Meijere, by original designation.

Readily differentiated from other Oscinellinae in Hawaii by the shape of the scutellum (fig. 175b), with the bristles situated on prominences, in combination with the densely gray pollinose thorax and other characteristics as pointed out under the species below. The scutellar shape is more nearly like that of *Rhodesiella* Adams (figs. 176c, 177g) than any other Hawaiian Chloropids, but by comparison it is not so greatly elongated, about as long as wide and scarcely two-fifths as long as mesonotum. Also, the wing venation is very different (fig. 175c), the last section of vein $M_1 + 2$ is not curved upward beyond m crossvein, and the body markings and other characteristics are very different from *Rhodesiella*; these are not related.

Meijerella flavisetosa Sabrosky (figs. 175a-d)

Meijerella flavisetosa Sabrosky, 1976, Pacif. Insects 17(1):93. Type-locality: Nuuanu Valley, Oahu.

Oahu (some reared from *Touchardia*, Urticaceae), Hawaii, Kauai, Maui, and Molokai. Earliest collection record, Manoa, Oahu, March, 1945. This is the species recorded by Wirth (1947) as *Conioscinella* sp.

Immigrant? Probably from the Oriental region.

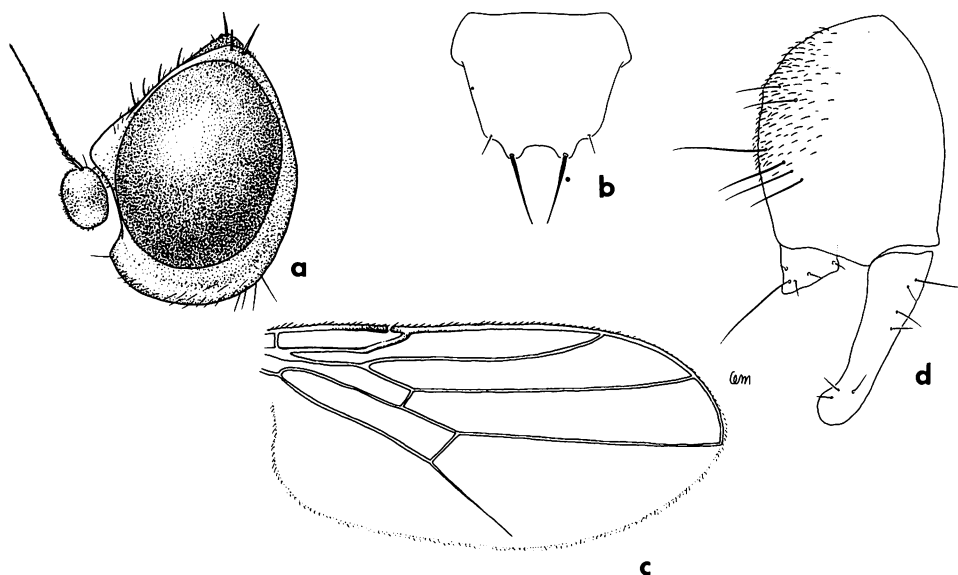


Figure 175—*Meijerella flavisetosa* Sabrosky: a, head, lateral; b, scutellum; c, wing; d; male genitalia, lateral.

Differentiated from other Hawaiian chloropids by the generic characters given above. Head shaped as in figure 175a with the eyes densely short pilose and almost circular. Genae about one-fourth to one-fifth the eye height. Third antennal segment about one-half higher than long and arista short pubescent. Head and appendages yellow except for brown ocellar triangle and eyes, also a tinge of brown on vertex and sometimes on third antennal segment. Front rather broad, wider than high as seen from direct dorsal view. A row of short yellow orbital bristles (seta-like), front entirely opaque yellow with triangle not clearly differentiated, its margins marked by a row of fine inconspicuous yellow hairs. Thorax mostly shining black in ground color covered by dense yellow-gray pollen (pubescence) and with three faint brown vittae extending down mesonotum; apical half of scutellum yellow and anterior portions of humeri yellow to rufous in ground color. Humeral bristles are lacking. Two notopleural, one postalar, and one posterior dorsocentral bristles are present on mesonotum. The posterior scutellar bristles are moderately developed, black, and situated on prominent tubercles. The secondary scutellars are small yellow, situated on small tubercles (fig. 175b). Legs mostly yellow, hind femora tinged with brown. Wings hyaline, veins yellow, venation as in figure 175c with r-m crossvein situated near apical two-thirds of cell 1st M_2 . First two terga mostly yellow, and apices of terga 4, 5, and all of 6 yellow. Venter entirely yellow to rufous. Genitalia as in figure 175d with the surstyli rather slender and the lobes arising from posterior margin of epandrium short and triangular.

Length: body, 2.0 mm.

Genus **RHODESIELLA** Adams

Rhodesiella Adams, 1905, Univ. Kansas Sci. Bull. 3:197. Type-species, *tarsalis* Adams, by original designation.

For synonymy refer to Sabrosky (1941a:762).

A large genus spread over the Ethiopian, Oriental, and Pacific regions. Also one species from continental United States (Stone, et al., 1965:781).

Shining black, densely short setose species characterized by the enlarged scutellum, as long as wide and about three-fifths as long as mesonotum; bare eyes; highly polished metallic blue or green (in Hawaiian species); smooth frontal triangle; large, strongly divergent ocellar bristles; two notopleural bristles; and by having conspicuous hairs on the mesopleura. Front with six or more pairs of bristles along orbits and about six pairs of interfrontal bristles (strong hairs). Third antennal segment short, higher than long in one species and as high as long in the other. The wings in the two Hawaiian species are as in figures 176e, 177c.

For keys to species refer to Becker (1911:88), under *Meroscinis* Meijere, and to Malloch (1931b), under *Macrostyla* Lioy.

Rhodesiella elegantula (Becker) (figs. 176a-e)

Meroscinis elegantula Becker, 1911, Annls hist.-nat. Mus. natn. hung. 9:89.

Type-locality: Formosa.

Macrostyla elegantula var. *hawaiiensis* Malloch, 1931, Ann. Mag. Nat. Hist. (10)8:66. Type-locality: Waimea, Hawaii.

Oahu, Kauai, Hawaii, probably on all the main islands. First collected at Waimea, Hawaii, and Palolo Valley, Oahu, in 1922 (Bryan, 1924:344).

Immigrant. Formosa, Philippines, Java.

Differentiated by the all yellow legs and slender femora. Frontal triangle metallic green, not so broadly truncate as in *scutellata*. Hairs along sides of frontal triangle, occipital and genal setae yellow, also labellum mostly yellow. Basal segments of antennae yellow, third brown except for narrow base; third antennal segment about as high as long and head slightly longer than high with the eyes oblique (fig. 176a). Mesonotum and scutellum yellow setose. Scutellum narrow in relation to its length, rounded at apex with apical bristles equal or longer than scutellum and secondary bristles well developed (fig. 176b). Posterior three-fifths of mesopleuron densely covered with rather long, yellow hairs. Third costal section subequal to fourth and last section of $M_1 + 2$ only slightly upcurved beyond m (fig. 176e). Male genitalia as in figure 176d.

Length: body, 3.0-4.0 mm.; wings, 2.5-3.3 mm.

Refer to Malloch (1931b:65) for a discussion of this species, under *Macrostyla*.

Rhodesiella scutellata (de Meijere) (figs. 177a-g)

Meroscinis scutellata de Meijere, 1908, Tijdschr. Ent. 51:172. Type-locality: Java.

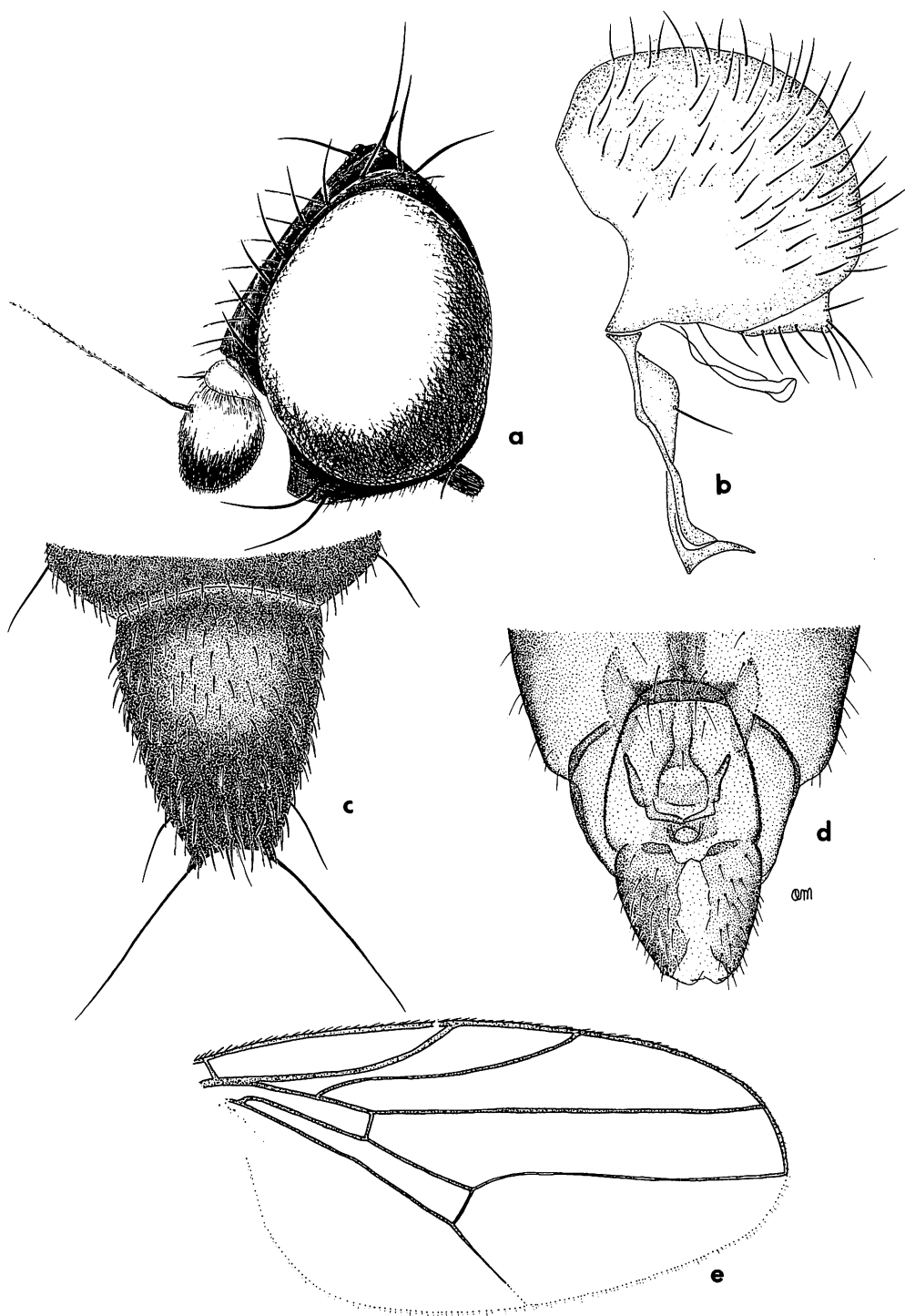


Figure 176—*Rhodsiella elegantula* (Becker): a, head, lateral; b, male genitalia, lateral; c, scutellum; d, male genitalia, ventral; e, wing.

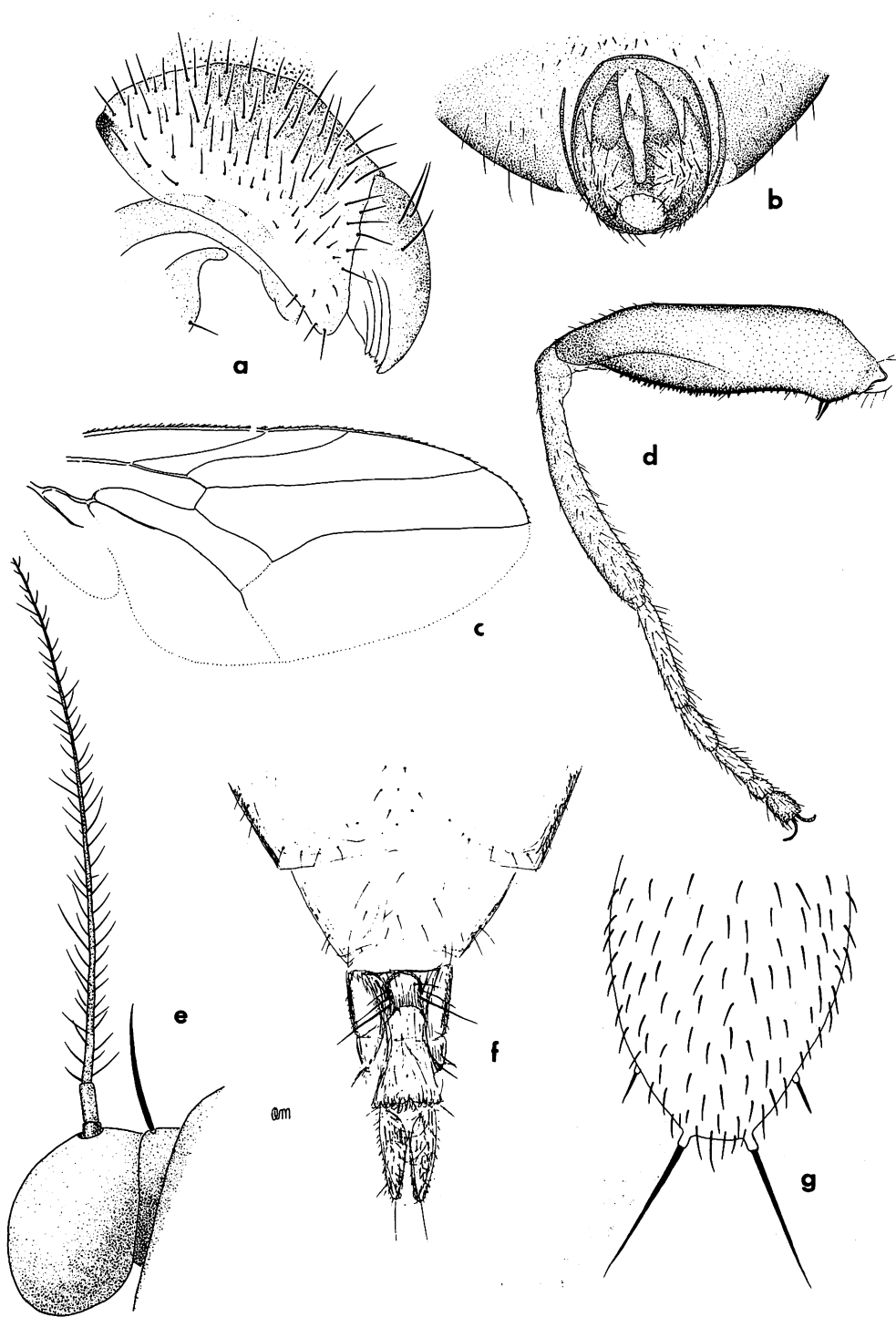


Figure 177—*Rhodesiella scutellata* (de Meijere): a, male genitalia, lateral; b, genitalia, ventral; c, wing; d, hind femur; e, antenna; f, post abdomen of female, ventral; g, scutellum.

Widespread on all the main Hawaiian Islands.

Immigrant. Java, Formosa, Philippines, south China, Singapore, also New Guinea.

Previous to 1947 (Wirth, 1947:22), this species was treated in the Hawaiian literature as *R. tarsalis* Adams; the latter is an African species. The earliest collection record for *scutellata* in Hawaii is April, 1914 (Bryan, 1924b:347).

Swezey (1935) reported this species killed by balsa flowers. These were dead inside the flowers at the base of the corolla tube.

Wilder (1929) implied that this fly breeds (probably as a scavenger) in the tunnels of wood-boring beetles. In his discussion of insects of breadfruit he stated, "Xyleborus also bored dead twigs and the chloropid fly, *Rhodesiella tarsalis* Adams followed after this beetle's work."

This species is readily differentiated from *elegantula* by the following characters: legs black except for yellow tarsi and extreme apices and bases of tibiae. Frontal triangle metallic blue, broadly truncate anteriorly. Prominent hairs (bristles) along sides of frontal triangle black. First two antennal segments black, third rufous except for a tinge of brown to black around upper apex; third distinctly higher than long (fig. 177e). Head higher than long, eyes not oblique; with occipital and genal setae black, also mouthparts black. Mesonotum and scutellum brown setose. Scutellum triangular with apical bristles shorter than scutellum and secondary bristles very tiny (fig. 177g). Hairs on mesopleuron confined to dorsal and posterior portions. Hind femur thickened, ventral surface densely covered with short, blunt spinules over apical three-fourths, and with a pair of short ventral spines near base in males (fig. 177d). Third costal section scarcely over half as long as fourth. Vein $M_1 + 2$ usually with a distinct upcurve just beyond m crossvein. The latter is obviously variable and some specimens have been seen which have $M_1 + 2$ nearly straight beyond m. Male genitalia as in figures 177a,b, female as in figure 177f.

Length: body, 2.25–3.0 mm., wings, 2.0–2.5 mm.

Refer to Malloch (1931b:55) for a discussion of this species, under *Macrostyla*.

***Rhodesiella sauteri* (Duda) (figs. 178a,b)**

Mesoscinis sauteri Duda, 1930, Stettin. Ent. Ztg. 91:286. Type-locality: Formosa.

Oahu.

Immigrant. Formosa. New record from Hawaiian Islands based upon three specimens collected in light trap, Honolulu, March, 1966, September, 1967, and April, 1969 (C. R. Joyce). Determined by C. W. Sabrosky as *R. sauteri*?

Fitting nearest to *scutellata* (de Meijere), but readily differentiated because of its tiny size, the body of specimens at hand measuring 1.4–1.5 mm. Also by having the hind femur not enlarged and lacking ventral spines near base; vein $M_1 + 2$ not curved sharply upward just beyond M crossvein; and the male genitalia very distinctive as shown in figures 178a,b. In other details it seems

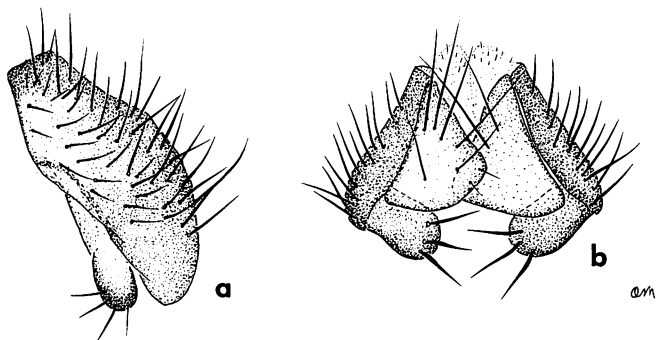


Figure 178—*Rhodesiella sauteri* (Duda): a, male genitalia, lateral; b, genitalia, ventral.

to fit the description of *scutellata*. The frontal triangle is polished black with a faint blue tinge as seen in direct light. The length of the third costal section, between apices of veins R_1 and $R_2 + 3$, apparently is variable; in two specimens it is half the length of fourth section, and in one specimen it is about two-thirds the length. The penultimate section of vein $M_1 + 2$ is equal in length to the last section of vein $M_3 + 4$. Male genitalia as in figures 178a,b. With the surstyli apparently bilobed, a large leaf-like dorsal lobe and a smaller ventral lobe; the latter has three strong bristles at apex, the former has a series of bristle-like setae near basal portion.

Genus **SIPHUNCULINA** Rondani

Siphunculina Rondani, 1856, Dipterol. ital. Prodr. 1:128. Type-species, *previnervis* Rondani, by original designation.

Microneurum Becker, 1903, Mitt. Zool. Mus. Berl. 2:152. Type-species, *maculifrons* Becker, by monotypy, = *ornatifrons* (Loew).

Liomicroneurum Enderlein, 1911, Sber. Ges. naturf. Freunde 1911:230. Type-species, *Siphonella funicola* de Meijere, by original designation.

Liriomicroneurum, emendation.

Reference: Sabrosky (1941a:758).

Characterized by the very short vein $R_2 + 3$, terminating about opposite m crossvein, making the third costal section (between tips of R_1 and $R_2 + 3$) about one-fourth as long as the fourth section (fig. 179c). Also by the prominent median carina on the face, and in the Hawaiian species by the densely gray pubescent markings over the front and mesonotum (fig. 179b). One species, *Siphunculina funicola* (de Meijere), is the common eye fly of India and is an important vector of infectious eye diseases and tropical sores.

Only one species known in Hawaii.

Siphunculina striolata (Wiedemann) (figs. 179a-e)

Chlorops striolatus Wiedemann, 1830, Aussereurop. zweifl. Ins. 2:597. Type-locality: China.

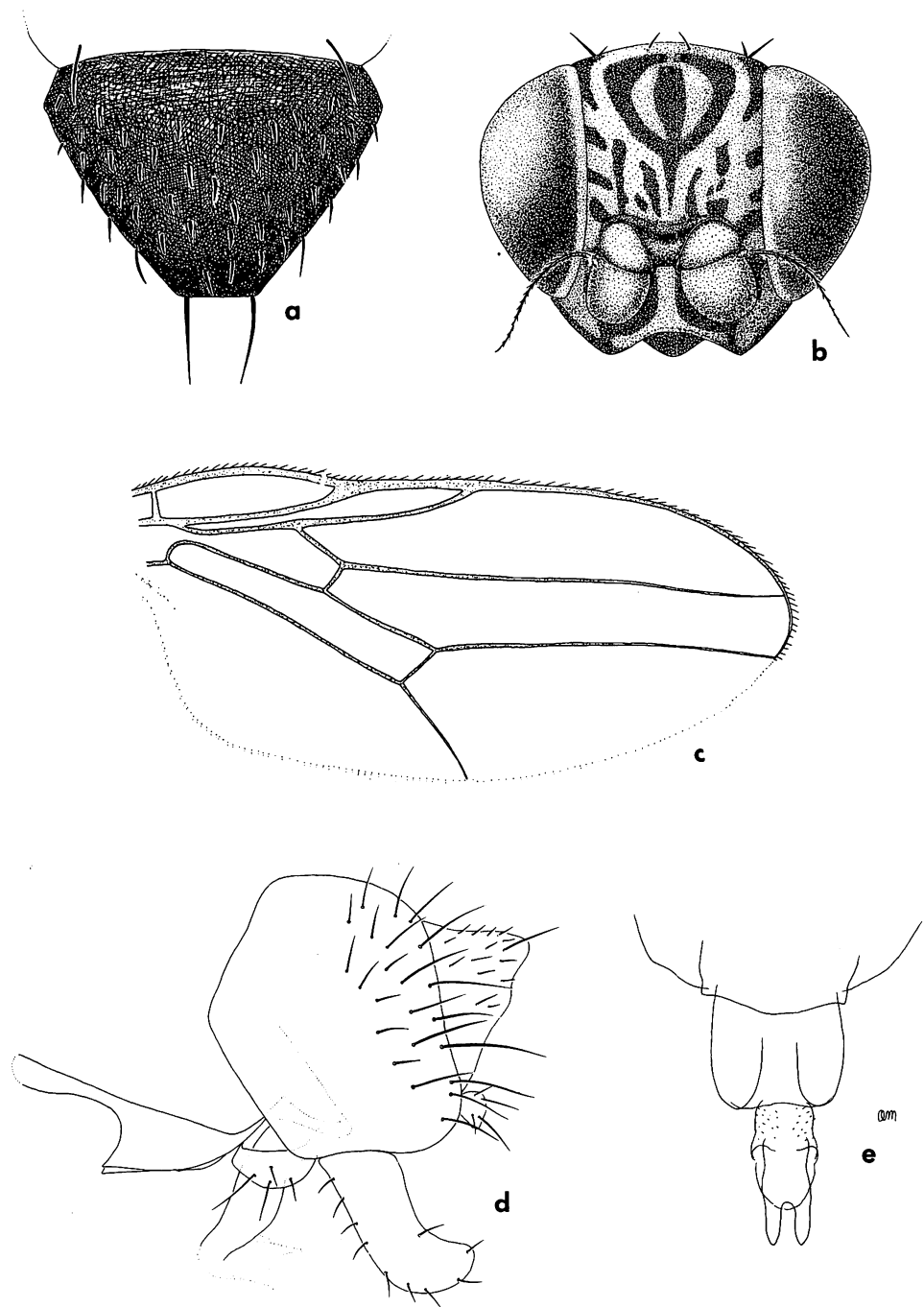


Figure 179—*Siphunculina striolata* (Wiedemann): a, scutellum; b, head, frontal view; c, wing; d, male genitalia, lateral; e, female ovipositor, ventral.

Oscinis signatum Wollaston, 1858, Ann. Mag. Nat. Hist. (3)1:117, pl. 5, fig. 8. Type-locality: Madeira. Synonymy by Sabrosky (pers. comm.).

Leeward Hawaiian Islands, Oahu, and Maui. Probably established on all of the main islands. First reported on the Leeward Hawaiian Islands and Oahu by Bryan (1931:335).

Immigrant. Widespread over tropics. Madeira, Arabia, Formosa, Fiji, and Cuba (Bezzi 1928:153). The species may be a scavenger. It has been bred from chicken manure on Oahu.

Readily differentiated by the characters given above and by the short, stubby scutellar bristles (fig. 179a) and the rather slender, geniculate proboscis. Mostly shining black with the mesonotum and front (fig. 179b) characteristically patterned with dense gray pubescence arranged in longitudinal, often confluent, streaks. The median carina and sides of face, also upper portion of each gena, are gray pubescent, and the pleura have two longitudinal streaks of gray on each of the mesopleuron and pteropleuron and a short streak on anterior median portion of sternopleuron. The frontal triangle extends about four-fifths the length of the front. The head bristles are very short, weak, almost setalike, with three pairs of orbital bristles represented and with a row of short, black setae on each side of ocellar triangle. Antennae rufous, third segment slightly higher than long, and arista short pubescent. Thoracic bristles also short and thick; two pairs notopleural bristles. Scutellum as in figure 179a, with one pair of short apical bristles and about two pairs of short seta-like bristles. Femora black; front and middle tibia rufous, tinged with brown medianly, and hind tibiae dark brown to black medianly, rufous at apices and bases. Tarsi yellow. Wings as in figure 179c. Male and female terminalia as in figures 179d,e.

Length: body and wings, 2.25–2.5 mm.

REFERENCES CITED

- ADACHI, M. S.
1952. NOTES. *Proc. Hawaii. ent. Soc.* 14:353-354.
- ALDRICH, J. M.
1912. BIOLOGY OF SOME WESTERN SPECIES OF THE DIPTEROUS GENUS *EPHYDRA*. *Jl. N.Y. ent. Soc.* 20:77-79, pls. 7-9.
1923. DESCRIPTIONS OF LANTANA GALL-FLY AND LANTANA SEED-FLY (DIPTERA). *Proc. Hawaii. ent. Soc.* 5:261-263.
1931. NEW ACALYPTRATE DIPTERA FROM PACIFIC AND ORIENTAL REGIONS. *Proc. Hawaii. ent. Soc.* 7:395-399.
- AU, S. H.
1969. NOTE. Hawaii cooperative Economic Insect Report, Nov. 14, 1969.
- AUSTIN, E. E.
1912. BRITISH FLIES THAT CAUSE MYIASIS IN MAN. *Local Govt. Bd. Pub. Health and Med. Subjs. (n.s.)* 66:5-15. London.
- BACK, E. A., and C. E. PEMBERTON
1914. LIFE HISTORY OF THE MELON FLY. *Jour. Agric. Res.* 3(3):269-274.
1917. THE MELON FLY IN HAWAII. *Bull. Bur. Ent. U.S. Dep. Agric.* 491:64 pp.
1918. THE MEDITERRANEAN FRUIT FLY IN HAWAII. *Bull. Bur. Ent. U.S. Dep. Agric.* 536. 119 pp.
- BARNES, H. F.
1937. THE ASPARAGUS MINER (*MELANAGROMYZA SIMPLEX* H. LOEW) (AGROMYZIDAE; DIPTERA). *Ann. App. Ent.* 24:574-588.
- BEARDSLEY, J. W.
1963. NOTE. *Proc. Hawaii. ent. Soc.* 13:216.
1966. INSECTS AND OTHER TERRESTRIAL ARTHROPODS FROM THE LEEWARD HAWAIIAN ISLANDS. *Proc. Hawaii. ent. Soc.* 19:157-185
- BEAVER, O., L. KNUTSON, and C. O. BERG
1977. BIOLOGY OF SNAIL-KILLING FLIES (SEPEDON) FROM SOUTHEAST ASIA (DIPTERA: SCIOMYZIDAE). *Proc. ent. Soc. Wash.* 79(3):326-337.
- BENJAMIN, F. H.
1934. DESCRIPTIONS OF SOME NATIVE TRYPETID FLIES WITH NOTES ON THEIR HABITS. *Bull. U. S. Dep. Agric.* 401:1-95.
- BERG, C. O.
1950. HYDRELLIA (EPHYDRIDAE) AND SOME OTHER ACALYPTRATE DIPTERA REARED FROM POTAMOGETON. *Ann. ent. Soc. Am.* 43:374-398.
1953. SCIOMYZID LARVAE THAT FEED ON SNAILS. *J. Parasit.* 39(6):630-636.
1961. BIOLOGY OF SNAIL-KILLING SCIOMYZIDAE OF NORTH AMERICA AND EUROPE. 11th Int. Congr. Ent., 1960, 1:197-202.
- BESS, H. A., and F. H. HARAMOTO
1958. BIOLOGICAL CONTROL OF PAMAKANI, *EUPATORIUM ADENOPHORUM*, IN HAWAII BY A TEPHRTID GALL FLY, *PROCECIDOCHARES UTILIS*. 1. THE LIFE HISTORY OF THE FLY AND ITS EFFECTIVENESS IN THE CONTROL OF THE WEED. *Proc. 10th Int. Congr. Ent.* 4:543-548.
1959. BIOLOGICAL CONTROL OF PAMAKANI. . . . 2. POPULATION STUDIES OF THE WEED, THE FLY AND THE PARASITES OF THE FLY. *Ecology* 40(2):244-249.
1972. BIOLOGICAL CONTROL OF PAMAKANI. . . . 3. STATUS OF THE WEED, FLY AND PARASITES OF THE FLY IN 1966-1971 VERSUS 1950-1957. *Proc. Hawaii. ent. Soc.* 21:165-178.
- BEZZI, M.
1913. INDIAN TRYPAEIDS (FRUIT-FLIES) IN THE COLLECTION OF THE INDIAN MUSEUM, CALCUTTA. *Mem. Indian Mus.* 3:53-175, pls. 8-10.
1919. NOTA SUL GENERE *CRYPTOCHAETUM* CON DESCRIZIONE DI UNA NUOVA SPECIE DELLE FILIPPINE. *Ann. Soc. Ital. Sci. Nat. Milano* 58:237-252.
1920. NOTES ON THE ETHIOPIAN FRUIT FLIES OF THE FAMILY TRUPANEIDAE, OTHER THAN *DACUS* III. *Bull. ent. Res.* 10:211-271.
1924. FURTHER NOTES ON THE ETHIOPIAN FRUIT FLIES WITH KEYS TO ALL THE KNOWN GENERA AND SPECIES. *Bull. ent. Res.* 15:73-135.
1928. DIPTERA BRACHYCERA AND ATHERICERA OF THE FIJI ISLANDS. *British Museum (Nat. Hist.)*. 220 pp.
- BIANCHI, F. A.
1941. NOTE. *Proc. Hawaii. ent. Soc.* 11:14.
- BLANCHARD, E.
1840. HISTOIRE NATURELLE DES INSECTES. ORTHOPTÈRES, NÉVROPTÈRES, HÉMIPTÈRES, HYMÉNOPTÈRES, LÉPIDOPTÈRES ET DIPTÈRES, vol. 3. 672 pp., 67 pls. In: Laporte, F. L. de, *Histoire naturelle des animaux articulés*. Paris.

- BOHART, G. E., and J. L. GRESSITT
1951. FILTH-INHABITING FLIES OF GUAM. Bull. Bernice P. Bishop Mus. 204. 152 pp., 17 pls.
- BÖVING, A. G.
1925. A SUMMER TRIP IN ICELAND SOUTH OF VATNA-JÖKUL. Proc. ent. Soc. Wash. 27:17-35.
- BOYES, J. W., L. V. KNUTSON, K. Y. JAN, and C. O. BERG
1969. CYTOTAXONOMIC STUDIES OF SCIOMYZIDAE. Trans. Am. microsc. Soc. 88(3):331-356.
- BRATT, A. D., L. V. KNUTSON, B. A. FOOTE, and C. O. BERG
1969. BIOLOGY OF PHERBELLIA (DIPTERA: SCIOMYZIDAE). Mem. Cornell agric. Exp. Stn. 404. 246 pp.
- BRIDWELL, J. C.
1919. DESCRIPTIONS OF NEW SPECIES OF HYMENOPTEROUS PARASITES OF MUSCOID DIPTERA WITH NOTES ON THEIR HABITS. Proc. Hawaii. ent. Soc. 4:166-179.
- BRYAN, E. H.
1921. PRELIMINARY NOTES ON THE GENUS TEPHRITIS IN HAWAII (DIPTERA). Proc. Hawaii. ent. Soc. 4:475-480.
1923a. NOTES ON DIPTERA. Proc. Hawaii. ent. Soc. 5:285-286.
1923b. NEW RECORDS, IDENTIFICATIONS AND SYNONYMY OF DIPTERA FOUND IN HAWAII. Proc. Hawaii. ent. Soc. 5:290-292.
1924a. HAWAIIAN TRYPETIDAE (DIPTERA). Proc. Hawaii. ent. Soc. 5:367.
1924b. NOTES. Proc. Hawaii. ent. Soc. 5:344, 347.
1926. NOTES. Proc. Hawaii. ent. Soc. 6:236.
1926a. NOTE. Proc. Hawaii. ent. Soc. 6:228.
1926b. EPHYDRID FLY NEW TO HAWAII. Proc. Hawaii. ent. Soc. 6:279.
1926c. INSECTS OF HAWAII, JOHNSTON ISLAND AND WAKE ISLAND. Bull. Bernice P. Bishop Mus. 31. 94 pp.
1927. NOTE. Proc. Hawaii. ent. Soc. 6:364.
1929. NOTE. Proc. Hawaii. ent. Soc. 7:235.
1931. NOTE. Proc. Hawaii. ent. Soc. 7:335-336.
1933. NOTES. Proc. Hawaii. ent. Soc. 8:230.
1934. A REVIEW OF THE HAWAIIAN DIPTERA, WITH DESCRIPTIONS OF NEW SPECIES. Proc. Hawaii. ent. Soc. 8:399-468.
- BUTLER, G. D., and R. L. USINGER
1963. INSECTS AND OTHER ARTHROPODS FROM KURE ISLAND. Proc. Hawaii. ent. Soc. 18:237-244.
- CHOCK, Q. C., C. J. DAVIS, and M. CHONG
1961. SEPEDON MACROPUS (DIPTERA: SCIOMYZIDAE). INTRODUCED INTO HAWAII AS A CONTROL FOR THE LIVER FLUKE SNAIL LYMNÆA OLLULA. J. econ. Ent. 54(1):1-4.
- CHONG, M.
1962. NOTE. Proc. Hawaii. ent. Soc. 18:25.
1969. NOTE. Proc. Hawaii. ent. Soc. 20:276.
- CLARKE, B. O.
1898. OFFICIAL BULLETIN OF THE BUREAU OF AGRICULTURE. The Hawaiian 1:6.
- COGAN, B. H.
1968. A REVISION OF THE ETHIOPIAN SPECIES OF THE TRIBE NOTIPHILINI (DIPTERA: EPHYDRIDAE). Bull. Br. Mus. nat. Hist. (Ent.) 21:281-365.
- COLLESS, D. H., and D. K. McALPINE
1970. DIPTERA. In: The Insects of Australia, pp. 658-740. Melbourne Univ. Press.
- COLLIN, J. E.
1949. THE PALAEARCTIC SPECIES OF THE GENUS APHANIOSOMA BECK. (DIPTERA, CHIROMYZIDAE). Ann. Mag. nat. Hist. 12(2):127-147.
- COLYER, C. N., and C. O. HAMMOND
1951. FLIES OF THE BRITISH ISLES. Frederick Warne and Co., London. 383 pp.
- COQUILLET, D. W.
1900. NEW GENERA AND SPECIES OF EPHYDRIDAE. Can. Ent. 32:33-36.
1910. THE TYPE SPECIES OF NORTH AMERICAN GENERA OF DIPTERA. Proc. U. S. natn. Mus. 37:499-647.
- CRESSON, E. T.
1918. COSTA RICAN DIPTERA COLLECTED BY PHILIP P. CALVERT, PHD, 1909-1910. PAPER III. A REPORT ON THE EPHYDRIDAE. Trans. Am. ent. Soc. 44:39-68.
1920. A REVISION OF NEARCTIC SCIOMYZIDAE. Trans. Am. ent. Soc. 46:27-89, 3 pls.
1922. DESCRIPTIONS OF NEW GENERA AND SPECIES OF THE DIPTEROUS FAMILY EPHYDRIDAE. Ent. News 33:135-137.
1925. STUDIES IN THE DIPTEROUS FAMILY EPHYDRIDAE, EXCLUDING THE NORTH AND SOUTH AMERICAN FAUNAS. Trans. Am. ent. Soc. 51:227-258.
1926. DESCRIPTIONS OF NEW SPECIES OF THE DIPTEROUS FAMILY. EPHYDRIDAE FROM HAWAII. Proc. Hawaii. ent. Soc. 6:275-278.
1930. STUDIES IN THE DIPTEROUS FAMILY EPHYDRIDAE, PAPER III. Trans. Am. ent. Soc. 56:93-131.
1932. STUDIES IN THE DIPTEROUS FAMILY EPHYDRIDAE, PAPER IV. Trans. Am. ent. Soc. 58:1-34.
1934. DESCRIPTIONS OF NEW GENERA AND SPECIES OF DIPTEROUS FAMILY EPHYDRIDAE—XI. Trans. Am. ent. Soc. 60:199-222.

1935. DESCRIPTIONS OF GENERA AND SPECIES OF THE DIPTEROUS FAMILY EPHYDRIDAE. *Trans. Am. ent. Soc.* 61:345-372.
1939. DESCRIPTIONS OF A NEW GENUS AND TEN NEW SPECIES OF EPHYDRIDAE, WITH A DISCUSSION OF THE SPECIES OF THE GENUS DISCOMYZA (DIPTERA). *Notul. ent.* 21:1-12.
1944. SYNOPSIS OF NORTH AMERICAN EPHYDRIDAE (DIPTERA). Parts IA and II. *Trans. Am. ent. Soc.* 70:159-180.
1945. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE INDO-AUSTRALIAN EPHYDRIDAE. I. THE SUBFAMILY PSILOPINAE. *Trans. Am. ent. Soc.* 71:47-75.
- 1946a. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE NEOTROPICAL EPHYDRIDAE (DIPTERA). I. THE SUBFAMILY PSILOPINAE. *Trans. Am. ent. Soc.* 71:129-163.
- 1946b. SYNOPSIS OF NORTH AMERICAN EPHYDRIDAE (DIPTERA). III. THE TRIBE NOTIPHILINI OF THE SUBFAMILY NOTIPHILINAE. *Trans. Am. ent. Soc.* 72:227-240.
- 1946c. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE ETHIOPIAN EPHYDRIDAE. I. THE SUBFAMILY PSILOPINAE. *Trans. Am. ent. Soc.* 72:241-264.
- 1947a. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE NEOTROPICAL EPHYDRIDAE (DIPTERA). II. THE SUBFAMILY NOTIPHILINAE. *Trans. Am. ent. Soc.* 73:35-61.
- 1947b. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE ETHIOPIAN EPHYDRIDAE. II. THE SUBFAMILY NOTIPHILINAE. *Trans. Am. ent. Soc.* 73:105-124.
1948. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE INDO-AUSTRALIAN EPHYDRIDAE. II. THE SUBFAMILY NOTIPHILINAE AND SUPPLEMENT TO PART I ON THE FAMILY PSILOPINAE. *Trans. Am. ent. Soc.* 74:1-28.
1949. A SYSTEMATIC ANNOTATED ARRANGEMENT OF THE GENERA AND SPECIES OF THE NORTH AMERICAN EPHYDRIDAE. IV. THE SUBFAMILY NAPAEINAE. *Trans. Am. ent. Soc.* (1948) 74:225-260.
- CURRAN, C. H.
1935. NEW AMERICAN DIPTERA. *Am. Mus. Novit.* 812:1-25, 4 figs.
- CURTIS, J.
1829. BRITISH ENTOMOLOGY: BEING ILLUSTRATIONS AND DESCRIPTIONS OF THE GENERA OF INSECTS FOUND IN GREAT BRITAIN AND IRELAND, vol. 6, pls. 242-289.
- CZERNY, L.
1927. HELOMYZIDAE. [Fam.] 53a, pp. 1-46. TRICHOSCELIDAE. [Fam.] 53b, pp. 46-51. CHIROMYIDAE. [Fam.] 53c, pp. 51-54. In: Lindner, E., ed., *Die Fliegen der palaearktischen Region*, vol. 5. Stuttgart.
1936. CHAMAEMYIIDAE (OCHTHIPHILIDAE). [Fam.] 51, pp. 1-25. In: Lindner, E., ed., *Die Fliegen der palaearktischen Region*, vol. 5. Stuttgart.
- DAHL, R. G.
1959. STUDIES ON SCANDINAVIAN EPHYDRIDAE (DIPTERA: BRACHYCERA). *Opusc. ent.* 15:224 pp.
- DAVIS, C. J.
1959. NOTES AND EXHIBITIONS. *Proc. Hawaii. ent. Soc.* 17:26-27.
1959. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—IV. *Proc. Hawaii. ent. Soc.* 17:62-66.
1960. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—V. *Proc. Hawaii. ent. Soc.* 17:244-248.
1961a. NOTE. *Proc. Hawaii. ent. Soc.* 17:315.
1961b. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—VI. *Proc. Hawaii. ent. Soc.* 17(3):389-393.
1969. NOTE. *Proc. Hawaii. ent. Soc.* 20:274.
1971. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—XVI. *Proc. Hawaii. ent. Soc.* 21:59-62.
1972. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—XVII. *Proc. Hawaii. ent. Soc.* 21(2):187-190.
1972. HAWAII COOPERATIVE ECONOMIC INSECT REPORT, October 1972.
- DAVIS, C. J., and N. L. H. KRAUSS
1962a. RECENT DEVELOPMENTS IN THE BIOLOGICAL CONTROL OF WEED PESTS IN HAWAII. *Proc. Hawaii. ent. Soc.* 18:65-67.
1962b. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—VII. *Proc. Hawaii. ent. Soc.* 18:125-129.
1964. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—IX. *Proc. Hawaii. ent. Soc.* 18:391-397.
1967. RECENT INTRODUCTIONS FOR BIOLOGICAL CONTROL IN HAWAII—XII. *Proc. Hawaii. ent. Soc.* 19:375-380.
- DELFINADO, M. D.
1969. SOME TYPE SPECIMENS OF PHILIPPINE DIPTERA DESCRIBED BY M. BEZZI IN THE MUSEO CIVICO DI STORIA NATURALE, MILANO. *Pacif. Insects* 11(1):165-173.
- DELFINADO, M. D., and D. E. HARDY, eds.
1977. A CATALOG OF THE DIPTERA OF THE ORIENTAL REGION, vol. III. The University Press of Hawaii, Honolulu. 854 pp.
- DRAKE, E.
1972. NOTE. *Proc. Hawaii. ent. Soc.* 21:143.

DUDA, O.

1918. REVISION DER EUROPÄISCHEN ARTEN DER GATTUNG LIMOSINA MACQUART (DIPTEREN). Verh. zool.-bot. Ges. Wien. 10(1):1-240, 8 pls.

1924a. BERICHTIGUNG ZUR REVISION DER EUROPÄISCHEN ARTEN DER GATTUNG LIMOSINA MACQUART (DIPTEREN) NEBST BESCHREIBUNG VON SECHS NEUEN ARTEN. Verh. zool.-bot. Ges. Wien. (1923) 73:163-180, 7 figs.

1924b. BEITRAG ZUR SYSTEMATIK DER LIMOSINA UNTERGATTUNGEN TRACHYOPELLA UND ELACHISOMA UND BESCHREIBUNG VON ELACHISOMA PILOSA SP.N. (FEMALE) (DIPTEREN). Konowia 3:5-9, 3 figs.

1924. BEITRAG ZUR SYSTEMATIK DER DROSOPHILIDEN UNTER BESONDERER BERÜCKSICHTIGUNG DER PALÄARTISCHEN UND ORIENTALISCHEN ARTEN (DIPTEREN). Arch. Naturgesch. 90(3):172-234, 7 pls, 104 figs.

1926. MONOGRAPHIE DER SEPSIDEN (DIPT.)—I. Wien. Naturhist. Mus. Ann. (1925) 39:1-153, 2 figs, 7 pls.

1931. DIE NEOTROPISCHEN CHLOROPIDEN (DIPT.). I. FORTSETZUNG: NACHTRAG, ERGÄNZUNGEN, BERICHTIGUNGEN UND INDEX. Folia Zool. et Hydrobiol. 3:159-172.

1938. SPHAEROCERIDAE (CYPSELIDAE). [Fam.] 57, pp. 1-182. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 6. Stuttgart.

EHRHORN, E. M.

1910. REPORT ON MEDITERRANEAN FRUIT FLY. Hawaiian Forester and Agriculturist 7:336.

FALLÉN, C. F.

1820. HETEROMYZIDES SVECIAE. Lund. 10 pp.

FISHER, T. W., and R. E. ORTH

1972. RESURRECTION OF SEPEDON PACIFICA CRESSON AND REDESCRIPTION OF SEPEDON PRAEMIOSA GIGLIO-TOS WITH BIOLOGICAL NOTES. Pan-Pacif. Ent. 48(1):8-20.

FOOTE, B. A.

1959. BIOLOGY AND LIFE HISTORY OF THE SNAIL-KILLING FLIES BELONGING TO THE GENUS SCIOMYZA FALLÉN. Ann. ent. Soc. Am. 52(1):31-43.

FOOTE, B. A., S. E. NEFF, and C. O. BERG

1960. BIOLOGY AND IMMATURE STAGES OF ATRICHOMELINA PUBERA. Ann. ent. Soc. Am. 53(2):192-199, 16 figs.

FOOTE, R. H.

1958. THE GENUS EUARESTOIDES IN THE UNITED STATES AND MEXICO (DIPTERA, TEPHRTIDAE). Ann. ent. Soc. Am. 51(3):288-293.

1960a. A REVISION OF THE GENUS TRUPANEA IN AMERICA NORTH OF MEXICO. Bull. U.S. Dep. Agric. 1214:1-27.

1960b. THE SPECIES OF THE GENUS NEOTEPHRTIS HENDEL IN AMERICA NORTH OF MEXICO (DIPTERA, TEPHRTIDAE). Jl. N.Y. ent. Soc. 68:145-151.

FOOTE, R. H., and F. L. BLANC

1963. THE FRUIT FLIES OR TEPHRTIDAE OF CALIFORNIA. Bull. Calif. Ins. Survey 7. 117 pp.

FREY, R.

1958. ZUR KENNTNIS DER DIPTERA BRACHYCERA P.P. DER KAPVERDISCHEN INSELN. Commentat. biol. 18:5-61, 20 figs., 1 map.

FRICK, K. E.

1952a. A GENERIC REVISION OF THE FAMILY AGROMYZIDAE (DIPTERA) WITH A CATALOGUE OF THE NEW WORLD SPECIES. Univ. Calif. Publs. Ent. 8(8):339-452.

1952b. FOUR NEW HAWAIIAN LIRIOMYZA SPECIES AND NOTES ON OTHER HAWAIIAN AGROMYZIDAE. Proc. Hawaii. ent. Soc. 14:509-518.

1953. FURTHER STUDIES ON HAWAIIAN AGROMYZIDAE (DIPTERA) WITH DESCRIPTIONS OF FOUR NEW SPECIES. Proc. Hawaii. ent. Soc. 15:207-215.

1959. SYNOPSIS OF THE SPECIES OF AGROMYZID LEAF MINERS DESCRIBED FROM NORTH AMERICA. Proc. U.S. natn. Mus. 108:347-465, 170 figs.

FUJII, J. K., and M. TAMASHIRO

1972. NOSEMA TEPHRTITAE SP. N., A MICROSPORIDIAN PATHOGEN OF THE ORIENTAL FRUIT FLY, DACUS DORSALIS HENDEL. Proc. Hawaii. ent. Soc. 21:191-203.

FULLAWAY, D. T.

1909. INSECTS OF COTTON IN HAWAII. Bull. Hawaiian Sug. Plrs' Ass. Exp. Stn. 18:1-27, 18 figs.

1912. INSECT PESTS. In: Higgens, J. E., The pineapple in Hawaii. Bull. Hawaiian Sug. Plrs' Ass. Exp. Stn 36:31-34.

1914. A LIST OF LAYSAN ISLAND INSECTS. Proc. Hawaii. ent. Soc. 3:20-22.

1915. NOTE. Proc. Hawaii. ent. Soc. 3:142.

1947. NOTE. Proc. Hawaii. ent. Soc. 13:8.

FUNASAKI, G.

1968. NOTE. Proc. Hawaii. ent. Soc. 20:15.

GERCKE, G.

1887. EINIGE BEOBSACHTUNGEN ÜBER DIE EIGENART DE CANACE RANULA LOEW. Wien. ent. Ztg 6:1-4.

GIFFARD, W. M.

1919. NOTE. Proc. Hawaii. ent. Soc. 4:181.

- GRIMSHAW, P. H.
 1901. DIPTERA. Pp. 1-77, 3 pls. In: Sharp, D., ed., Fauna Hawaiiensis 3(1). Cambridge, England.
 1902. DIPTERA (SUPPL.). Pp. 79-86. In: Sharp, D., ed., Fauna Hawaiiensis 3(2). Cambridge, England.
- HALE, D.
 1968. NOTE. Proc. Hawaii. ent. Soc. 20:4.
- HAMMER, O.
 1941. BIOLOGICAL AND ECOLOGICAL INVESTIGATIONS ON FLIES ASSOCIATED WITH PASTURING CATTLE AND THEIR EXCREMENT. Dansk Naturhist. For. Kobenhaven, Vidensk. Meddel. 105:141-393, 50 figs.
- HARDY, D. E.
 1949. STUDIES IN HAWAIIAN FRUIT FLIES. Proc. ent. Soc. Wash. 51(5):181-205.
 1950. HOMONEURA VS. SCIOMYZA IN HAWAII (DIPTERA). Proc. Hawaii. ent. Soc. 14:73.
 1951. NOTE. Proc. Hawaii. ent. Soc. 14:227.
 1952a. ADDITIONS AND CORRECTIONS TO BRYAN'S CHECKLIST OF THE HAWAIIAN DIPTERA. Proc. Hawaii. ent. Soc. 14:443-484D.
 1952b. NOTE. Proc. Hawaii. ent. Soc. 14:346.
 1952c. NOTE. Proc. Hawaii. ent. Soc. 14:363.
 1952d. FLIES COLLECTED IN BAIT TRAPS. Proc. Hawaii. ent. Soc. 14:407-409.
 1952e. NOTE. Proc. Hawaii. ent. Soc. 14:355.
 1953. NOTE. Proc. Hawaii. ent. Soc. 15:7.
 1955. A RECLASSIFICATION OF THE DACINI (TEPHRITIDAE-DIPTERA). Ann. ent. Soc. Am. 48(6):425-437, 4 pls.
 1956. NOTE. Proc. Hawaii. ent. Soc. 16:9.
 1957. NOTE. Proc. Hawaii. ent. Soc. 16:188.
 1958. NOTES. Proc. Hawaii. ent. Soc. 16:339-340.
 1959. NOTE. Proc. Hawaii. ent. Soc. 17:7.
 1963. NOTES. Proc. Hawaii. ent. Soc. 18:210-211.
 1965. NOTES. Proc. Hawaii. ent. Soc. 19:7, 19.
 1967. NOTES. Proc. Hawaii. ent. Soc. 19:326, 330, 333.
 1968. NOTE. Proc. Hawaii. ent. Soc. 20:13.
 1969. TAXONOMY AND DISTRIBUTION OF THE ORIENTAL FRUIT FLY AND RELATED SPECIES (TEPHRITIDAE-DIPTERA). Proc. Hawaii. ent. Soc. 20:395-428, 17 figs.
 1972. NOTES. Proc. Hawaii. ent. Soc. 21:151.
- HARRISON, R. A.
 1959. ACALYPTERATE DIPTERA OF NEW ZEALAND. N.Z. Dept. of Sci. and Indust. Res. Bull. 128. 382 pp.
- HENDEL, F.
 1903. KRITISCHE BEMERKUNGEN ZUR SYSTEMATIK DER MUSCIDAE ACALYPTERATAE. Wien. ent. Ztg 22:249-252.
 1911. ÜBER DIE SEPEDON-ARTEN DER ÄTHIOPISCHEN UND INDO-MALAYISCHEN REGION. Annls hist.-nat. Mus. natn. hung. 9:266-277.
 1914. ACALYPTERATE MUSCIDEN. Supplta ent. 3:90-116.
 1925. NEUE ÜBERSICHT ÜBER DIE BISHER BEKANNT GEWORDENEN GATTUNGEN DER LAUXANIIDEN, NEBST BESCHREIBUNG NEUEN GATTUNGEN UND ARTEN. Encycl. ent. (B) II, Dipt. 2:103-112.
 1927. TRYPETIDAE. [Fam.] 49, pp. 1-221. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1930. EINE NEUE INTERESSANTE EPHYDRIDENGATTUNG. (DIPT.). Konowia 9:66-70, 3 figs.
 1931. KRITISCHE UND SYNONYMISCHE BEMERKUNGEN ÜBER DIPTEREN. Verh. zool.-bot. Ges. Wien 81:4-19.
 1934. REVISION DER TETHINIDEN. Tijdschr. Ent. 77:35-54.
 1937. MILICHIIDAE ET CARNIDAE. [Fam.] 60a, pp. 1-91. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 6, pt. 1. Stuttgart.
- HENNIG, W.
 1938. BEITRÄGE ZUR KENNTNIS DES KOPULATIONSAPPARATES UND DER SYSTEMATIK DER ACALYPTERATEN. I. CHAMAEMYIIDAE UND ODINIIDAE (DIPTERA). Arb. morph. taxon. Ent. Berl. 5(3):201-213, 1 pl.
 1939a. OTITIDAE (PTEROCALLIDAE UND ORTALIDAE). [Fams.] 46-47, pp. 1-78. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1939b. BEITRÄGE ZUR KENNTNIS DER KOPULATIONSAPPARATES UND DER SYSTEMATIK DER ACALYPTERATEN. II. TETHINIDAE, MILICHIIDAE, ANTHOMYZIDAE UND OPOMYZIDAE. Arb. morph. taxon. Ent. Berl. 6:81-94.
 1940. ULIDIIDAE. [Fam.] 45, pp. 1-34. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1943. PIOPHILIDAE. [Fam.] 40, pp. 1-52. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1945. PLATYSTOMIDAE. [Fam.] 48, pp. 1-56. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1949. SEPSIDAE. [Fam.] 39a, pp. 49-91. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
 1956. BEITRAG ZUR KENNTNIS DER MILICHIIDEN LARVEN. Beitr. ent. Z. 6(1/2):138-145.

1958. DIE FAMILIEN DER DIPTERA SCHIZOPHORA UND IHRE PHYLOGENETISCHEN VERWANDSCHAFTS-BEZIEHUNGEN. Beitr. ent. Z. 8:505-688.
1969. NEUE GATTUNGEN UND ARTEN DER ACALYPTERATAE. Can. Ent. 101(6):589-633, 72 figs.
1971. NEUE UNTERSUCHUNGEN ÜBER DIE FAMILIEN DER DIPTERA SCHIZOPHORA. Stutt. Beitr. Naturk. 226(3):1-76, 108 figs.
- HERING, E. M.
1947. SIRUNA SEVA BLÄTTER FÜR FRUCHTFLIEGEN-KUNDE 6:1-16. Berlin.
1951. BIOLOGY OF THE LEAF MINERS. Dr. W. Junk, The Hague. 420 pp.
- HOWARD, L. O.
1901. DIPTERA COLLECTED IN HAWAII BY H. W. HENSHAW. Proc. ent. Soc. Wash. 4:490.
- ILLINGWORTH, J. F.
1914. NOTES ON TWO SPECIES OF HAWAIIAN DIPTERA. Proc. Hawaii. ent. Soc. 3:270-272.
1923a. INSECT FAUNA OF HEN MANURE. Proc. Hawaii. ent. Soc. 5:270-273.
1923b. INSECTS ATTRACTED TO CARRION IN HAWAII. Proc. Hawaii. ent. Soc. 5:280-281.
1926a. PINEAPPLE INSECTS AND SOME RELATED PESTS. Assoc. Haw. Pineapple Cannery Expt. Sta. Bull. 9. 64 pp.
1926b. NOTE. Proc. Hawaii. ent. Soc. 6:224.
1927. A REPORT ON INSECTS AND OTHER ANIMAL ORGANISMS COLLECTED IN THE PINEAPPLE GROWING SECTION AT MAUNA LOA, MOLOKAI, JUNE 1926. Proc. Hawaii. ent. Soc. 6:390-397.
1929a. PESTS OF PINEAPPLE IN HAWAII. Proc. Hawaii. ent. Soc. 7:254-256.
1929b. NOTE. Proc. Hawaii. ent. Soc. 7:233-234.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE.
1955. OPINION 348. SUPPRESSION UNDER THE PLENARY POWERS OF THE GENERIC NAME TITANIA MEIGEN 1800, FOR THE PURPOSE OF VALIDATING THE GENERIC NAME CHLOROPS MEIGEN, 1803 (CLASS INSECTA, ORDER DIPTERA), pp. 421-436 (= pt. 15). In: Hemming, F. ed., Opinions and declarations rendered by the International Commission on Zoological Nomenclature 10. London. 562 pp., 1 pl.
- JAMES, M. T.
1947. THE FLIES THAT CAUSE MYIASIS IN MAN. U.S. Dept. Agric. Mis. Pub. 631:175 pp.
- JOHANNSEN, O. A.
1935. AQUATIC DIPTERA. PART II. ORTHORRHAPHA-BRACHYCERA AND CYCLORRHAPHA. Cornell Univ. Agr. Exp. Sta. Mem. 177. 74 pp., 12 pls.
- JONES, B. J.
1906. CATALOGUE OF THE EPHYDRIDAE, WITH BIBLIOGRAPHY AND DESCRIPTIONS OF NEW SPECIES. Univ. Calif. Pubs. Ent. 1:153-198, 4 figs.
- JOYCE, C. R.
1955. NOTES AND EXHIBITIONS. Proc. Hawaii. ent. Soc. 15:374.
1968. NOTES. Proc. Hawaii. ent. Soc. 20:2, 19.
- KAJIWARA, J.
1964. NOTE. Proc. Hawaii. ent. Soc. 18:339.
- KERTÉSZ, K.
1913. ÜBER EINIGE MUSCIDAE ACALYPTERATAE, LAUXANIINAE. Annls hist.-nat. Mus. natn. hung. 11:88-102.
- KNAB, F.
1916. DISPERSAL OF SOME ORTALIDAE. Bull. Brooklyn ent. Soc. 11(2):40-46.
- KNUTSON, L. V.
1966. BIOLOGY AND IMMATURE STAGES OF MALACOPHAGOUS FLIES: ANTICHAETA ANALIS, A. ATRISETA, A. BREVIPENNIS AND A. OBLIVIOSA. Trans. Am. ent. Soc. 92:67-101.
- KNUTSON, L. V., and C. O. BERG
1963. BIOLOGY AND IMMATURE STAGES OF A SNAIL-KILLING FLY, HYDROMYA DORSALIS (FABRICIUS). Proc. Roy. Ent. Soc. Lond. (A) 38:45-58.
1964. BIOLOGY AND IMMATURE STAGES OF SNAIL-KILLING FLIES: THE GENUS ELGIVA. Ann. ent. Soc. Am. 57:173-192.
- KNUTSON, L. V., and L. LYNEBORG
1965. DANISH ACALYPTERATE FLIES. 3. SCIOMYZIDAE. Ent. Meddr 34:61-101.
- KNUTSON, L. V., S. E. NEFF, and C. O. BERG
1967. BIOLOGY OF SNAIL-KILLING FLIES FROM AFRICA AND SOUTHERN SPAIN. Parasitology 57:487-505.
- KNUTSON, L. V., J. W. STEPHENSON, and C. O. BERG
1965. BIOLOGY OF A SLUG-KILLING FLY, TETANOCERA ELATA. Proc. Malac. Soc. Lond. 36:213-220.
- KRAUSS, N. L. H.
1941. NOTE. Proc. Hawaii. ent. Soc. 11:15.
1945. NOTES ON SOME HAWAIIAN INSECTS. Proc. Hawaii. ent. Soc. 12:309-317.
1963. NOTE. Proc. Hawaii. ent. Soc. 18:217.
- LAWRENCE, B. R.
1954. THE LARVAL INHABITANTS OF COW PATS. J. Anim. Ecol. 23(2):234-260.
1955. THE ECOLOGY OF SOME BRITISH SPHAEROCERIDAE (BOBORIDAE-DIPTERA). J. Anim. Ecol. 24(1):187-199, 5 figs.

- LINDROTH, C. H.
1931. DIE INSECTENFAUNA ISLANDS UND IHRE PROBLEME. Zool. Bidr. Uppsala 13:105-589, 50 figs.
- LOEW, H.
1869. DIPTERA AMERICAE SEPTENTRIONALIS INDIGENA. Berl. ent. Z. 13:1-52.
1873. MONOGRAPHS OF THE DIPTERA OF NORTH AMERICA. PART III. Smithsn. misc. Collns 11(3):1-351, 4 pls.
- McALPINE, J. F.
1960a. DIPTERA (BRACHYCERA) LONCHAEIDAE. South African Animal Life 7:327-376, 13 figs.
1960b. A NEW SPECIES OF LEUCOPIS (LEUCOPELLA) FROM CHILE AND A KEY TO THE WORLD GENERA AND SUBGENERA OF CHAMAEMYIIDAE (DIPTERA). Can. Ent. 92(1):51-58, 5 figs.
1963. RELATIONSHIPS OF CREMIFANIA CZERNY (DIPTERA: CHAMAEMYIIDAE) AND DESCRIPTION OF A NEW SPECIES. Can. Ent. 95(3):239-253, 12 figs.
1964. DESCRIPTIONS OF NEW LONCHAEIDAE (DIPTERA) 1. AND 2. Can. Ent. 96:661-757.
1970. IDENTITIES OF LONCHAEID FLIES DESCRIBED BY KERTÉSZ WITH NOTES ON RELATED SPECIES (DIPTERA: LONCHAEIDAE). Can. Ent. 102(4):442-453.
1971. A REVISION OF THE SUBGENUS NEOLEUCOPIS (DIPTERA: CHAMAEMYIIDAE). Can. Ent. 103:1851-1874.
- MALLOCH, J. R.
1914. NOTES ON THE DIPTEROUS GENUS CHYROMYA R.-D. Proc. ent. Soc. Wash. 16:179-181.
1920. SOME NEW SPECIES OF THE GENUS LONCHAEA (DIPTERA, LONCHAEIDAE). Can. Ent. 52:246-247.
1920. SOME NEW NORTH AMERICAN SAPROMYZIDAE (DIPTERA). Can. Ent. 52:126-128.
1921. FOREST INSECTS IN ILLINOIS. I. THE SUBFAMILY OCHTHIPHILINAE (DIPTERA, FAMILY AGROMYZIDAE). Bull. Ill. Lab. nat. Hist. 13(14):345-361, 2 pls.
1923. SOME NEW GENERA AND SPECIES OF LONCHAEIDAE AND SAPROMYZIDAE (DIPTERA). Proc. ent. Soc. Wash. 25:45-53.
1927a. A NEW SPECIES OF SAPROMYZIDAE FROM THE HAWAIIAN ISLANDS (DIPTERA). Proc. Hawaii. ent. Soc. 6:383-384.
1927b. THE SPECIES OF THE GENUS STENOMICRA COQUILLETT (DIPTERA, ACALYPTRATA). Ann. Mag. nat. Hist., ser. 9, 20:23-26, 1 pl.
1930a. INSECT OF SAMOA. Part 6, Fasc. 5. Diptera: Ortalidae, pp. 215-231. British Museum.
1930b. INSECTS OF SAMOA. Part 6, Fasc. 6. Diptera: Lonchaeidae, Chloropidae and Piophilidae, pp. 239-251. British Museum.
1931a. EXOTIC MUSCARIDAE (DIPTERA)—xxxii. Ann. Mag. nat. Hist., ser. 10, 7:314-340.
1931b. EXOTIC MUSCARIDAE (DIPTERA)—xxxiv. Ann. Mag. nat. Hist., ser. 10, 8:49-70.
1931c. NEW ZEALAND MUSCIDAE ACALYPTRATAE. TRYPETIDAE. Rec. Cant. Mus. 3(8):389-404.
1931d. NOTES ON AUSTRALIAN DIPTERA xxvii. Proc. Linn. Soc. N. S. Wales 66:60-78.
1933. DIPTERA OF PATAGONIA AND SOUTH CHILE. TRYPETIDAE. British Museum 6(4):263-296.
1934. INSECTS OF SAMOA. Part 6, Fasc. 8. Diptera: Drosophilidae, Ephydriidae, Sphaeroceridae and Milichiidae, pp. 267-328. British Museum.
1935a. SOME ACALYPTRATE DIPTERA FROM THE MARQUESAS ISLANDS. In: Marquesan Insects II. Bull. Bernice P. Bishop Mus. 114:3-31.
1935b. ADDITIONAL NEW SPECIES AND OTHER RECORDS OF ACALYPTRATE DIPTERA (SAPROMYZIDAE, ASTEIIDAE, DROSOPHILIDAE, EPHYDRIDAE AND TRYPETIDAE) FROM THE MARQUESAS ISLANDS. In: Marquesan Insects II. Bull. Bernice P. Bishop Mus. 114:179-200.
1939a. THE DIPTERA OF THE TERRITORY OF NEW GUINEA. VII. FAMILY OTITIDAE. Proc. Linn. Soc. N. S. W. 64(1-2):97-154.
1939b. THE DIPTERA OF THE TERRITORY OF NEW GUINEA. XI. Proc. Linn. Soc. N.S.W. 64(3-4):409-465.
1940a. SOME SAPROMYZIDAE (DIPTERA) FROM THE SOLOMON ISLANDS AND NEW CALEDONIA. Nov. Zoo. 42(1):131-146, 1 pl.
1940b. THE NORTH AMERICAN GENERA OF THE DIPTEROUS SUBFAMILY CHAMAEMYIINAE. Ann. and Mag. Nat. Hist. ser. 11, 6:265-274.
- MALLOCH, J. R., and W. L. McATEE
1924. KEYS TO FLIES OF THE FAMILIES LONCHAEIDAE, PALLOPTERIDAE AND SAPROMYZIDAE OF THE EASTERN UNITED STATES, WITH A LIST OF THE SPECIES OF THE DISTRICT OF COLUMBIA REGION. Proc. U.S. natn. Mus. 65(12):1-26, 2 pls.
- MASON, A. C.
1932. THE ECONOMIC IMPORTANCE OF THE MEDITERRANEAN FRUIT FLY TO HAWAIIAN HORTICULTURE. Proc. Hawaii. ent. Soc. 8:163-178.
- MAXWELL-LEFROY, H.
1909. INDIAN INSECT LIFE; A MANUAL OF THE INSECTS OF THE PLAINS (TROPICAL INDIA). Agricultural Research Institute, Pusa; Thacker, Spink & Co., Calcutta. xii, 786 pp., front. (map), illus. 84 pl. (part col.).
- MELANDER, A. L.
1913. A SYNOPSIS OF THE DIPTEROUS GROUPS AGROMYZINAE, MILICHIINAE, OCHTHIPHILINAE AND GEOMYZINAE. Jl. N.Y. ent. Soc. 21:283-300.
1920. REVIEW OF THE NEARCTIC TETANOCERIDAE. Ann. ent. Soc. Am. 13(3):305-332, 1 pl.
1924. REVIEW OF THE DIPTEROUS FAMILY PIOPHILIDAE. Psyche, Camb. 31:78-86.
1952. THE NORTH AMERICAN SPECIES OF TETHINIDAE (DIPTERA). Jl. N.Y. ent. Soc. 59:187-212.

- MELANDER, A. L., and A. SPULER
1917. THE DIPTEROUS FAMILIES SEPSIDAE AND PIOPHILIDAE. State College of Wash. Agric. Expt. Stat. Div. Ent. and Zoo. Bul. 143:97 pp.
- MITCHELL, W. C.
1951. NOTE. Proc. Hawaii. ent. Soc. 14:224.
- MIYAGI, I.
1965. ON THE JAPANESE SPECIES OF THE GENUS PROCANACE HENDEL, WITH DESCRIPTIONS OF SEVEN NEW SPECIES. Insecta Matsum. 27(2):85-98.
- MOORE, H. B.
1958. MARINE BIOLOGY. John Wiley & Sons, Inc., New York. 493 pp.
- MORGE, G.
1959. MONOGRAPHIE DER PALAEARKTISCHEN LONCHAEIDAE (DIPTERA). Beitr. Ent. 9:1-92, 323-371, 909-945, 171 figs.
1963. DIE LONCHAEIDAE UND PALLOPTERIDAE ÖSTERREICHS UND DER ANGRENZENDEN GEBIETE. 1. LONCHAEIDAE. Sonderd. aus Naturk. Jahrb. der Stadt Linz 1963:123-312. 241 figs.
- MUESEBECK, C. F. W.
1963. A NEW HAWAIIAN OPIUS FROM A LEAF-MINING PEST OF BEANS (HYMENOPTERA: BRACONIDAE). Proc. Hawaii. ent. Soc. 18:289-290.
- MUNRO, H. K.
1964. THE GENUS TRUPANEA IN AFRICA. Rep. S. Afr. Dept. Agric. Tech. Serv., Ent. Mem. 8. 101 pp., 313 figs.
- NAKAO, H.
1964. NOTE. Proc. Hawaii. ent. Soc. 18:334.
- NEAL, M. C.
1965. IN GARDENS OF HAWAII. Bernice P. Bishop Museum Special Publ. 50, rev. ed. 924 pp.
- NEFF, S. E., and C. O. BERG
1966. BIOLOGY AND IMMATURE STAGES OF MALOCOPHAGOUS DIPTERA OF THE GENUS SEPEDON (SCIOMYZIDAE). Bull. Agric. Expt. Sta. Virginia Polytech. Inst. 566:5-113.
- NISHIDA, T., and H. A. BESS
1950. STUDIES ON THE ECOLOGY AND CONTROL OF THE MELON FLY DACUS (STRUMETA) CUCURBITAE COQUILLETT. Haw. Agric. Expt. Sta. U. Haw. Tech. Bull. 34:3-44.
1970. A HANDBOOK OF FIELD METHODS FOR RESEARCH ON RICE STEM BORERS AND THEIR NATURAL ENEMIES. Intern. Biol. Prog. Handbook no. 14. 132 pp.
- NOWAKOWSKI, J. T.
1962. INTRODUCTION TO A SYSTEMATIC REVISION OF THE FAMILY AGROMYZIDAE (DIPTERA) WITH SOME REMARKS ON HOST PLANT SELECTION BY THESE FLIES. Annls. Zool. Warsz. 20(8):67-183.
- ODUM, E. P.
1959. FUNDAMENTALS OF ECOLOGY. 2d. ed. W. B. Saunders Company, Philadelphia. 546 pp.
- OTA, A., and T. NISHIDA
1966. A BIOLOGICAL STUDY OF PHYTOBIA (AMAUROMYZA) MACULOSA (DIPTERA: AGROMYZIDAE). Ann. ent. Soc. Am. 59(5):902-911.
- OTANES, F. Q.
1918. THE BEAN FLY. Philipp. Agric. 7(1):2-31.
- PATHAK, M. D.
1967. INSECT PESTS OF RICE. The international Rice Research Institute. Los Baños, Laguna, The Philippines. 68 pp. (Unpublished manuscript.)
- PERKINS, R. C. L.
1903. THE LEAF HOPPER OF THE SUGAR CANE. Haw. Board of Agric. and Forestry, Ento. Bull. 1. 38 pp.
- PERKINS, R. C. L., and O. H. SWEZEY
1924. THE INTRODUCTION INTO HAWAII OF INSECTS THAT ATTACK LANTANA. Bull. Hawaiian Sug. Plrs' Ass. Exp. Stn. 16:1-83, 7 figs., 1 pl.
- QUISENBERRY, B. F.
1951. A STUDY OF THE GENUS TEPHRITIS LATREILLE IN THE NEARCTIC REGION NORTH OF MEXICO. J. Kans. ent. Soc. 24(2):56-72.
- RAFINESQUE, C. S.
1815. ANALYSE DE LA NATURE OU TABLEAU DE L'UNIVERS ET DES CORPS ORGANISÉS. Palermo. 224 pp.
- RICHARDS, O. W.
1930. THE BRITISH SPECIES OF SPHAEROCERIDAE (BORBORIDAE: DIPTERA). Proc. zool. Soc. Lond., Gen. Meeting 1930:261-345, 1 pl., 23 text figs.
1952. SPHAEROCERIDAE (DIPTERA) FROM HAWAII. Proc. Hawaii. ent. Soc. 14:429-431.
1956. A NEW SPECIES OF LEPTOCERA OLIVIER FROM HAWAII (DIPTERA: SPHAEROCERIDAE). Proc. Hawaii. ent. Soc. 16:135-137, 1 fig.
1962. SPECIES OF COPROMYZA ALLIED TO SORDIDA (DIPTERA: SPHAEROCERIDAE), WITH NOTES ON TYPES OF AFRICAN SPHAEROCERIDAE DESCRIBED BY C. F. ADAMS. J. Kans. ent. Soc. 35(4):364-368, 6 figs.
1963. SPHAEROCERIDAE (BORBORIDAE). Insects of Micronesia 14(5):109-134, 12 figs.

1965. SPHAEROCERIDAE. In: Stone et al., A catalog of the Diptera of America north of Mexico. U.S. Dept. Agric., Handbook no. 276, pp. 718-726.
- SABROSKY, C. W.
 1936. A SYNOPSIS OF THE NEARCTIC SPECIES OF OSCINELLA AND MADIZA, BASED UPON A STUDY OF THE TYPES (DIPTERA, CHLOROPIDAE). J. Kans. ent. Soc. 8:105-116, 1 pl.
 1936. A REVIEW OF THE NEARCTIC SPECIES OF CHLOROPISCA (DIPTERA, CHLOROPIDAE). Can. Ent. 68:170-177.
 1939. A SUMMARY OF FAMILY NOMENCLATURE IN THE ORDER DIPTERA. 7th Int. Kongr. Ent., Berlin 1938, pp. 599-612.
 1940. CHLOROPIDAE (DIPTERA) OF THE ORIENTAL REGION: NOTES AND SYNONYMY. Ann. Mag. nat. Hist., ser. 11, 6:418-427.
 1941a. AN ANNOTATED LIST OF THE GENOTYPES OF THE CHLOROPIDAE OF THE WORLD (DIPTERA). Ann. ent. Soc. Am. 34:735-765.
 1941b. THE HIPPELATES FLIES OR EYE GNATS: PRELIMINARY NOTES. Can. Ent. 73:23-27.
 1943a. NEW GENERA AND SPECIES OF ASTEIIDAE (DIPTERA), WITH A REVIEW OF THE FAMILY IN THE AMERICAS. Ann. ent. Soc. Am. 36:501-514, 5 figs.
 1943b. A REVISED SYNOPSIS OF NEARCTIC THAUMATOMYIA (= CHLOROPISCA) (DIPTERA, CHLOROPIDAE). Can. Ent. 75:109-117.
 1946. FAMILY NAMES IN THE ORDER DIPTERA. Proc. ent. Soc. Wash. 48(7):163-171.
 1947. A NEW SPECIES OF THE DIPTEROUS FAMILY ASTEIIDAE FROM HAWAII. Proc. Hawaii. ent. Soc. 13:55-57.
 1951a. CHLOROPIDAE. Brit. Mus. (Nat. Hist.) Ruwenzori Exped. 2(7):711-827.
 1951b. A REVIEW OF THE NEARCTIC SPECIES OF LASIOPLEURA (DIPTERA, CHLOROPIDAE). Can. Ent. 83(12):336-343.
 1951c. A REVISION OF THE NEARCTIC SPECIES OF THE GENUS GAURAX (DIPTERA, CHLOROPIDAE). Am. Mus. Nat. 45(2):407-431.
 1956. ADDITIONS TO THE KNOWLEDGE OF OLD WORLD ASTEIIDAE [DIPTERA]. Revue Fr. Ent., fasc. 4, 23:216-243, 9 figs.
 1957a. INSECTS OF MICRONESIA DIPTERA: ASTEIIDAE. Insects Micronesia (1956) 14:29-40, 1 fig.
 1957b. SYNOPSIS OF THE NEW WORLD SPECIES OF THE DIPTEROUS FAMILY ASTEIIDAE. Ann. ent. Soc. Am. 50:43-61.
 1959. A REVISION OF THE GENUS PHOLEOMYIA IN NORTH AMERICA (DIPTERA, MILICHIIDAE). Ann. ent. Soc. Am. 52(3):316-331.
 1964. ADDITIONS AND CORRECTIONS TO THE WORLD LIST OF TYPE SPECIES OF CHLOROPIDAE. Ent. News 75:177-185.
 1965. DIPTERA FROM NEPAL. ASIATIC SPECIES OF THE GENUS STENOMICRA (DIPTERA: ANTHOMYZIDAE). Bull. Br. Mus. nat. Hist., Ent. 17:209-218, 5 figs.
 1976. A NEW GENUS AND SPECIES OF CHLOROPIDAE FROM HAWAII (DIPTERA). Pacif. Insects 17(1):91-97.
- SABROSKY, C. W., and W. W. WIRTH
 1956. NOTE. Proc. Hawaii. ent. Soc. 16:18.
 1958. A FORMOSAN EPHYDRID NEW TO HAWAII (DIPTERA: EPHYDRIDAE). Notul. ent. 38:109-110.
- SACK, P.
 1939. SCIOMYZIDAE. [Fam.] 37, pp. 1-87, 4 pls. In: Lindner, E., ed., Die Fliegen der palaearktischen Region, vol. 5. Stuttgart.
- SASAKAWA, M.
 1960. A STUDY OF THE JAPANESE AGROMYZIDAE, PART 1. Sci. Reports of the Kyoto Pref. Univ. 12:76-82.
 1961. A STUDY OF THE JAPANESE AGROMYZIDAE (DIPTERA), PART 2. Pacif. Insects 3(2-3):307-472.
 1964a. A REVISION OF THE HAWAIIAN LIRIOMYZA. Proc. Hawaii. ent. Soc. 18:429-433.
 1964b. DESCRIPTION OF A NEW OPHIOMYZIA SPECIES AND OCCURRENCE OF PHYTOMYZA PLANTAGINIS IN HAWAII. Proc. Hawaii. ent. Soc. 18:425-427.
- SÉGUY, E.
 1951. ORDRE DES DIPTÈRES (DIPTERA LINNÉ, 1758). In: Grassé, P.-P., ed., Traité de zoologie, Anatomie, Systématique Biologie, vol. 10, pp. 449-744, figs. 438-713, pl. 4.
- SEVERIN, H. H. P., and W. J. HARTUNG
 1912. WILL THE MEDITERRANEAN FRUIT FLY (CERATITIS CAPITATA WIED.) BREED IN BANANAS UNDER ARTIFICIAL AND FIELD CONDITIONS? J. econ. Ent. 5(6):443-451.
- SHEWELL, G. E.
 1965. FAMILY LAUXANIIDAE. In: Stone et al., A catalog of the Diptera of America north of Mexico, pp. 695-706.
 1966. AN ORIENTAL SPECIES OF HOMONEURA WULP APPARENTLY INTRODUCED INTO SOUTHEASTERN UNITED STATES. Proc. ent. Soc. Wash. 68(3):212-213.
- SHIRAKI, T.
 1968. FRUIT FLIES OF THE RYUKYU ISLANDS. Bull. U.S. natn. Mus. 263. 104 pp.
- SHOLDT, L. L.
 1966. INSECTS ASSOCIATED WITH THE FLOWERS OF THE COCONUT PALM, COCOS NUCIFERA L. IN HAWAII. Proc. Hawaii. ent. Soc. 19:293-296.

- SILVESTRI, F.
1914. REPORT OF AN EXPEDITION TO AFRICA IN SEARCH OF THE NATURAL ENEMIES OF FRUIT FLIES. *Haw. Bd. Agric. Forest. Ent. Bul.* 3. 176 pp., 24 pls.
- SIMMONS, P.
1927. THE CHEESE SKIPPER AS A PEST IN CURED MEATS. *U. S. Dept. Agric. Bull.* 1453. 56 pp.
- SMITH, K. G. V.
1963. A SHORT SYNOPSIS OF BRITISH CHAMAEMYIIDAE (DIPT.). *Trans. Soc. Br. Ent.* 15(6):103-115.
- SPENCER, K. A.
1963a. DIPTERA: AGROMYZIDAE. *Insects of Micronesia* 14(5):135-162, 10 figs.
1963b. A SYNOPSIS OF THE NEOTROPICAL AGROMYZIDAE (DIPTERA). *Trans. R. ent. Soc. London.* 115(12):291-389, 104 figs.
1963c. THE AUSTRALIAN AGROMYZIDAE (DIPTERA, INSECTA). *Rec. Austr. Mus.* 25(15):305-354, 78 figs.
1964a. THE SPECIES-HOST RELATIONSHIP IN THE AGROMYZIDAE (DIPTERA) AS AN AID TO TAXONOMY. 12th Int. Congr. Ent., London, pp. 1-6.
1964b. A REVISION OF THE PALAEARCTIC SPECIES OF THE GENUS OPHIOMYIA BRASCHNIKOV. *Beitr. Ent.* 14(7/8):773-822, 85 figs.
1964c. THE GENUS PHYTOLIRIOMYZA HENDEL (AGROMYZIDAE, DIPTERA): A CLARIFICATION OF THE FOUR EUROPEAN SPECIES, WITH A LIST OF EIGHT OTHER SPECIES NOW KNOWN IN THE GENUS. *Ann. Mag. nat. Hist. Ser. 13, vol. 7*:657-663.
1966a. A REVISION OF EUROPEAN SPECIES OF THE GENERA MELANAGROMYZA HENDEL AND HEXOMYZA ENDERLEIN, WITH A SUPPLEMENT ON THE GENUS OPHIOMYIA BRASCHNIKOV. *Beitr. Ent.* 16(1/2):3-60.
1966b. AGROMYZIDAE (DIPTERA) FROM THE BISMARCK ARCHIPELAGO WITH AN APPENDIX ON SOME RELATED SPECIES FROM THE ORIENTAL REGION. *Ent. Meddr.* 34:489-520.
1969. THE AGROMYZIDAE OF CANADA AND ALASKA. *Mem. ent. Soc. Canada* 64. 311 pp., 540 figs.
1973. AGROMYZIDAE (DIPTERA) OF ECONOMIC IMPORTANCE. 418 pp. *W. Junk B. V., The Hague.*
- SPULER, A.
1924. NORTH AMERICAN SPECIES OF THE SUBGENERA OPACIFRONS DUDA AND PTEREMIS RONDANI OF THE GENUS LEPTOCERA OLIVIER (DIPTERA: BORBORIDAE). *Psyche, Camb.* 31(3-4):121-134, 10 figs.
- STEGMAIER, C. E.
1967. HOST PLANTS OF LIRIOMYZA BRASSICAE, WITH RECORDS OF THEIR PARASITES FROM SOUTH FLORIDA. *The Florida Ent.* 50(4):257-261.
- STEPHENSON, T. A., and A. STEPHENSON
1949. THE UNIVERSAL FEATURES OF ZONATION BETWEEN TIDE MARKS ON ROCKY COAST. *J. Ecol.* 37:289-305.
- STEYSKAL, G. C.
1951. THE GENUS SEPEDON LATREILLE IN THE AMERICAS (DIPTERA: SCIOMYZIDAE). *Wasmann. J. Biol.* (1950)8:271-297. 5 pls.
1952. ULIDIINAE (DIPTERA, OTITIDAE) OF AUSTRALASIAN REGIONS. *Bull. Bernice P. Bishop Mus.* 20(15):277-287.
1954a. THE SCIOMYZIDAE OF ALASKA. *Proc. ent. Soc. Wash.* 56:54-71, 12 figs.
1954b. THE AMERICAN SPECIES OF THE GENUS DICTYA MEIGEN. *Ann. ent. Soc. Am.* 47(3):511-539.
1961a. THE NORTH AMERICAN SCIOMYZIDAE RELATED TO PHERBELLIA FUSCIPES (MACQUART). *Mich. Acad. Sci. Arts and Letters, Papers* 46:405-415, 7 figs.
1961b. THE GENERA OF PLATYSTOMATIDAE AND OTITIDAE KNOWN TO OCCUR IN AMERICA NORTH OF MEXICO. *Ann. ent. Soc. Am.* 54:401-410.
1963a. THE GENUS NOTOGRAMMA LOEW. *Proc. ent. Soc. Wash.* 65(3):195-200.
1963b. TAXONOMIC NOTES ON SCIOMYZIDAE. *Mich. Acad. Sci. Arts Letters, Papers* 48:113-125.
1964. DESCRIPTIONS AND SYNONYMICAL NOTES ON LIRIOMYZA MUNDA (DIPTERA: AGROMYZIDAE). *Ann. ent. Soc. Am.* 57(3):388-389.
1965a. FAMILY SCIOMYZIDAE. In: Stone et al., *A catalog of Diptera of America north of Mexico*, pp. 685-695.
1965b. THE SUBFAMILIES OF SCIOMYZIDAE OF THE WORLD. *Ann. ent. Soc. Am.* 58(4):593-594.
1973. A NEW CLASSIFICATION OF THE SEPEDON GROUP OF THE FAMILY SCIOMYZIDAE (DIPTERA) WITH TWO NEW GENERA. *Ent. News* 84:143-146.
1974. A NEW SPECIES OF PROCECIDOCHARES (DIPTERA: TEPHRITIDAE) CAUSING GALLS ON STEMS OF HAMAKUA PAMAKANI (AGERATINA RIPARIA: ASTERACEAE) IN HAWAII. *Coop. Econ. Insect Rep.* 24(32):639-641.
- STONE, A.
1942. NEW SPECIES OF ANASTREPHA AND NOTES ON OTHERS (DIPTERA, TEPHRITIDAE). *Journ. Wash. Acad. Sci.* 32(10):298-304.
- STONE, A., C. W. SABROSKY, W. W. WIRTH, R. H. FOOTE, and J. R. COULSON
1965. A CATALOG OF THE DIPTERA OF AMERICA NORTH OF MEXICO. *Agric. Res. Serv., U.S. Dept. Agric., Washington, D.C.* 1696 pp.
- STURTEVANT, A. H.
1923. NEW SPECIES AND NOTES ON SYNONYMY AND DISTRIBUTION OF MUSCIDAE ACALYPTERATAE. *Am. Mus. Novit.* 76. 12 pp.
1926. THE SEMINAL RECEPTACLES AND ACCESSORY GLANDS OF THE DIPTERA, WITH SPECIAL REFERENCE TO THE ACALYPTERAE. *Jl. N.Y. ent. Soc.* 34:1-21, 31 figs.

1954. NEARCTIC FLIES OF THE FAMILY PERISCHELIDAE (DIPTERA) AND CERTAIN ANTHOMYZIDAE REFERRED TO THE FAMILY. *Proc. U.S. natn. Mus* 103:551-561.
- STURTEVANT, A. H., and M. R. WHEELER
 1954. SYNOPSIS OF NEARCTIC EPHYDRIDAE (DIPTERA). *Trans. Am. ent. Soc.* 79:151-257.
- SWEZEY, O. H.
 1914a. NOTES. *Proc. Hawaii. ent. Soc.* 3:3, 4, 12.
 1914b. INSECTS FROM PALMYRA ISLANDS. *Proc. Hawaii. ent. Soc.* 3:15-16.
 1915. NOTE. *Proc. Hawaii. ent. Soc.* 3:70-71.
 1917. NOTE. *Proc. Hawaii. ent. Soc.* 3:272.
 1924. NOTE. *Proc. Hawaii. ent. Soc.* 5:389-390.
 1925. NOTE. *Proc. Hawaii. ent. Soc.* 6:48.
 1935. NOTE. *Proc. Hawaii. ent. Soc.* 9:11.
 1937. NOTE. *Proc. Hawaii. ent. Soc.* 10:11.
 1946. SOME MISCELLANEOUS DIPTERA OF GUAM. INSECTS OF GUAM II. *Bull. Bernice P. Bishop Mus.* 189:195-200.
1954. FOREST ENTOMOLOGY IN HAWAII. *Bernice P. Bishop Mus. Spec. Pub.* 44. 266 pp.
- TAMASHIRO, M., and D. H. HABECK
 1963. SERPENTINE LEAF MINER CONTROL ON POLE BEANS. *Haw. Farm Sci.* 12(3):7-9.
- TENORIO, J. A.
 1967. TWO NEW SPECIES OF LEPTOCERA OLIVIER FROM HAWAII (DIPTERA: SPHAEROCERIDAE). *Proc. Hawaii. ent. Soc.* 19:425-429.
1968. TAXONOMIC AND BIOLOGICAL STUDIES OF HAWAIIAN SPHAEROCERIDAE (DIPTERA). *Proc. Hawaii. ent. Soc.* 20:169-212.
- THORPE, W. H.
 1930. THE BIOLOGY OF THE PETROLEUM FLY (*PSILOPA PETROLII* COQ.). *Trans. ent. Soc. Lond.* 78:331-334, 4 figs.
 1931. THE BIOLOGY, POST-EMBRYONIC DEVELOPMENT, AND ECONOMIC IMPORTANCE OF *CRYPTOCHAETUM ICERYAE* (DIPTERA, AGROMYZIDAE) PARASITIC ON *ICERYA PURCHASI* (COCCIDAE, MONOPHLEBINI). *Proc. zool. Soc. Lond.* 1930(3-4): 929, 971, 23 figs.
- TIMBERLAKE, P. H.
 1920. NOTE. *Proc. Hawaii. ent. Soc.* 4:330.
 1924a. RECORDS OF THE INTRODUCED AND IMMIGRANT CHALCID-FLIES OF THE HAWAIIAN ISLANDS. *Proc. Hawaii. ent. Soc.* 5:418-449.
 1924b. NOTE. *Proc. Hawaii. ent. Soc.* 5:361.
 1926. NEW SPECIES OF HAWAIIAN CHALCID-FLIES (HYMENOPTERA). *Proc. Hawaii. ent. Soc.* 6(2):305-320.
- TUXEN, S. L.
 1944. THE HOT SPRINGS, THEIR ANIMAL COMMUNITIES AND THEIR ZOOGEOGRAPHICAL SIGNIFICANCE. *Zoology Iceland.* 1(2):1-206.
- VAN ZWALUWENBURG, R. H.
 1947. NOTE. *Proc. Hawaii. ent. Soc.* 13:30.
- VOCKEROTH, J. R.
 1961. THE NORTH AMERICAN SPECIES OF THE FAMILY OPOMYZIDAE (DIPTERA: ACALYPTERAE). *Can. Ent.* 93(7):503-522.
- WALKER, F.
 1849. LIST OF THE SPECIMENS OF DIPTEROUS INSECTS IN THE COLLECTION OF THE BRITISH MUSEUM, vol. 4, pp. 689-1172.
- WARREN, A.
 1914. NOTES ON A NEW EPHYDRID FLY. *Proc. Hawaii. ent. Soc.* 3:25.
- WESTWOOD, J. O.
 1840. ORDER XIII. DIPTERA ARISTOTLE (ANTLIATA FABRICIUS, HALTERIPTERA CLAIRV.). In: *An introduction to the modern classification of insects, synopsis of the genera of British insects.* London. 158 pp.
- WHEELER, M. R.
 1961. NEW SPECIES OF SOUTHWESTERN ACALYPTERATE DIPTERA. *The Southwest Naturalist* 6(2):86-91.
- WIGGLESWORTH, V. B.
 1947. *THE PRINCIPLES OF INSECT PHYSIOLOGY.* 3rd ed. Methuen and Co. London. 434 pp.
- WILDER, G. P.
 1924. NOTE. *Proc. Hawaii. ent. Soc.* 5:365.
 1929. NOTE. *Proc. Hawaii. ent. Soc.* 7:215.
- WILLARD, H. F.
 1927. SOME OBSERVATIONS ON THE ECOLOGY OF THE MEDITERRANEAN FRUIT FLY *CERATITIS CAPITATA* WIEDEMANN AND ITS PARASITES. *Proc. Hawaii. ent. Soc.* 6(3):505-515.
- WILLIAMS, F. X.
 1931. HANDBOOK OF THE INSECTS AND OTHER INVERTEBRATES OF HAWAIIAN SUGAR CANE FIELDS. *Hawaiian Sugar Planters' Association*, Honolulu. 400 pp., 190 figs.
 1933. NOTE. *Proc. Hawaii. ent. Soc.* 8:223.
 1938. BIOLOGICAL STUDIES IN HAWAIIAN WATER-LOVING INSECTS. PART III. DIPTERA OR FLIES. A. EPHYDRIDAE AND ANTHOMYZIDAE. *Proc. Hawaii. ent. Soc.* 10:85-119.

1939. BIOLOGICAL STUDIES IN HAWAIIAN WATER-LOVING INSECTS. PART III. DIPTERA OR FLIES. B. ASTEIIDAE, SYRPHIDAE AND DOLICHOPODIDAE. *Proc. Hawaii. ent. Soc.* 10:281-315.
- WILLISTON, S. W.
1898. ON THE DIPTERA OF ST. VINCENT (WEST INDIES). *Trans. ent. Soc. Lond.* 1896:253-446, pls. 8-14.
- WIRTH, W. W.
1947. NOTE. *Proc. Hawaii. ent. Soc.* 13:21-22.
1947. EPHYDRA GRACILIS PACKARD, A RECENT IMMIGRANT FLY IN HAWAII. *Proc. Hawaii. ent. Soc.* 13:141-142.
1948. A TAXONOMIC STUDY OF HAWAIIAN EPHYDRIDAE (DIPTERA) RELATED TO SCATELLA ROBINEAU-DESVOIDY. *Proc. Hawaii. ent. Soc.* 13:277-304.
1951. A REVISION OF THE DIPTEROUS FAMILY CANACEIDAE. *Occ. Papers Bernice P. Bishop Mus.* 20(14):241-275, 6 figs.
1964. A REVISION OF THE SHORE FLIES OF THE GENUS BRACHYDEUTERA LOEW (DIPTERA: EPHYDRIDAE). *Ann. ent. Soc. Am.* 57:3-12.
1965. EPHYDRIDAE. In: Stone et al., *A catalog of the Diptera of America north of Mexico*, pp. 743-759.
1968. EPHYDRIDAE. 77. In: *a catalogue of the Diptera of the Americas south of the United States*. Dept. Zool., Sec. Agr., São Paulo. 43 pp.
1969. THE SHORE FLIES OF THE GENUS CANACEOIDES CRESSON (DIPTERA: CANACEIDAE). *Proc. Calif. Acad. Sci.*, 4th ser., 36:551-570, 35 figs.
- WIRTH, W. W., and A. STONE
1956. AQUATIC DIPTERA. In: Usinger, R. L., *Aquatic insects of California*, pp. 372-482. Univ. Cal. Press, Berkeley.
- WULP, F. M. VAN DER
1891. EENIGE UITLANDSCHE DIPTERA. *Tijdschr. Ent.* 34:193-218, 1 pl.
1900. BIOLOGIA CENTRALI-AMERICANA. *Insecta Diptera* 2:419-420, pl. 12, fig. 23.
- YAMADA, T., S. NAKAGAWA, and H. KAMASAKI
1963. IDENTIFICATION OF THREE SPECIES OF REARED HAWAIIAN FRUIT FLY PUPAE. *Proc. Hawaii. ent. Soc.* 18:319-321.
- ZETTERSTEDT, J. W.
1847. DIPTERA SCANDINAVIAE. *Disposita et descripta* 6:2163-2580. Lund.
- ZUMPT, F.
1965. MYIASIS IN MAN AND ANIMALS IN THE OLD WORLD. Butterworths, London. 267 pp.

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